POWER
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Running on the Leavings

IF YOU were buying an automobile and some kind friend should offer you one that he was getting through with for the pittance for which he could trade it in, would you take it and be satisfied?

He has had the years of its useful and dependable service. Repairs and renewals are getting costly, and vexatious and expensive interruptions to journeys become frequent.

When you compute the interest and depreciation on the sacrifice price of somebody's leavings and on the price of a new car you will probably conclude that the difference is not too much to pay for something modern and serviceable, something that you needn't be afraid to drive out of sight of a service station.

An editor of *Power*, visiting a dilapidated old plant, was told that all the equipment in the place had been written off long ago. It was therefore most economical to continue to run it, since it cost nothing.

The years had not only got in their work upon the poor old outfit but had wrought improvements in the new. Machinery was available that would turn out more work with fewer interruptions, less power and less labor per unit of product.

And the cost per unit of product is what places one at an advantage or disadvantage in competition. There are a lot of charges, administrative and otherwise, besides those on the productive machinery, and these charges go on all the time.

The greater the production the less the overhead per unit of output, and it would not take a great increase in production per machine and per man-hour to much more than offset the fixed charges on a plant that would do it.

The end of a moribund plant like that visited by the editor is not many years away. It will linger and die as the firm fossilizes and the business succumbs to more wakeful competition.

Or will somebody see the light?

F. R. Low

POWER *Stands for . . .*

1. **Making Power When It Should Be Made**
2. **Buying Power When It Should Be Bought**
3. **Cheaper Power Through Modern Equipment**
4. **Easier Financing of Equipment Purchases**
5. **Better Use of Byproduct Heat and Power**
6. **Operating Methods That Save Money**
7. **Less Waste in Transmission and Application**
8. **Prevention of Smoke, Within Reason**

Measuring Byproduct Power Plant Performance

THE growing practice of delivering surplus byproduct power from industrial plants to central power systems reveals limitations in the usual methods of determining plant performance.

Over-all thermal efficiency, computed by adding the heat equivalents of process steam and kilowatt-hours to obtain "output," does not establish the true effectiveness of operation in plants having a buyer for surplus byproduct power. For example, a plant might, by an insignificant increase in fuel consumption, increase its boiler pressure, lower its process pressure and install more efficient generating units, thereby greatly increasing the amount of power for sale, and yet show no improvement in over-all "efficiency."

Clearly, steam and electricity must be considered separately. Kilowatts are "cream" skimmed from the "milk" of process steam. A market for kilowatts usually makes a given amount of heat more valuable as electricity than as process steam. With such an outlet the problem is to generate as much steam as possible from a ton of coal and get as much power as possible from that steam.

To get back to practical fundamentals, what of value is obtained from the fuel burned? Process steam and kilowatt-hours only. Then why not state that the given plant produces so many pounds of process steam and so many kilowatt-hours per unit weight of fuel. To avoid fractions, this fuel unit might be one thousand pounds.

For one preferring to measure in terms of heat units, it may be said that "*such* per cent of the heat in the fuel goes to process steam and *such* per cent to kilowatts."

One may object with reason to this double standard of "performance" on the basis that it makes comparisons difficult. For example, no one can say, solely from the viewpoint of performance, whether a plant delivering nine thousand pounds of process steam and two hundred kilowatt-hours per thousand pounds of fuel is better or worse than one delivering eight thousand pounds and three hundred kilowatts.

Yet these units, imperfect as they may be, give important information that fits naturally into any cost system.

The Fly Ash Problem

THE FACT that fly ash from pulverized coal furnaces is so fine as to diffuse in the atmosphere and be thinly spread over large areas has usually precluded its being a nuisance in the vicinity of the plant. For a time many engineers were inclined to condone this, in lieu of a solution to the problem, and gave attention only to such cases as were objects of complaint. Cinders from stokers, being larger and heavier, are prone to settle near the plant, but are more easily arrested by one of the many forms of cinder catchers.

With increased size of boilers and present practice of forcing, it is apparent that the fly-ash problem must be faced although it has not reached the nuisance stage. As a result many engineers are now engaged upon working out a solution.

While there are now available a number of devices that have proved their worth, within limits, it is generally conceded that the subject warrants further study and experimentation under operating conditions.

The amount of combustible in ash varies widely, and the problem is closely related to that of smoke abatement, but present standards by which smoke density is measured do not apply to ash. It is comparatively easy to catch the larger particles of ash and cinder, and it is possible, through the installation of more elaborate equipment, to catch the bulk of very fine ash. But the economic limit to which one is justified in going often presents a vexing problem in which the frequency and duration of peaks, the frequency of soot blowing and the plant location are factors.

It is commendable that the owners and managements of many of the larger plants are taking the initiative in the solution of this problem before it becomes a recognized nuisance.

The National Hydraulic Laboratory

THERE are now before Congress identical bills, known in the Senate as S-3043 and in the House as HR-8299, to establish in the Bureau of Standards a national hydraulic laboratory "for the determination of fundamental data useful in hydraulic research and engineering, including laboratory research relating to the behavior and control of river and harbor waters, the study of hydraulic structures and water flow and the development and testing of hydraulic instruments and accessories." They provide for a board of administration to be known as the National Hydraulic Laboratory Board, consisting of the Secretaries of Commerce, War, Interior and Agriculture, or their representatives. The passage of the bills will carry an appropriation of $350,000, to be spent "by the Secretary of Commerce for the building and equipment of a suitable laboratory on the site of the Bureau of Standards in Washington, D.C."

Major General Lytle Brown, Chief of Engineers in the War Department, who succeeded General Jadwin,

has given the bills the endorsement withheld by his department for six years previous. It is hoped that now there will be no further opposition.

The first investigations looking to the establishment of a national hydraulic laboratory were made under authority of a Senate joint resolution introduced by Senator Ransdell of Louisiana the early part of September, 1922, largely at the behest of John R. Freeman, who was greatly impressed with the need for something of the sort after completing a personal inspection of the lower Mississippi flood areas.

The history of the legislation shows clearly the difficulty in obtaining governmental action upon a subject requiring special knowledge for its understanding. Failure of the bills to pass in prior sessions of Congress is attributed largely to the opposition of the former Chief of Engineers in the War Department, as the proposed legislation seemed to threaten the jurisdiction of the army engineers in matters affecting rivers and harbors. There has also been a tendency to minimize, and even to question in its entirety, the usefulness of small-scale models in the study of flood- and tidal-water flow. During the past few years, however, the growth of experimental work of this sort both abroad and in the United States has been of such magnitude and so beneficial that there no longer can be any doubt of its efficacy.

The Mississippi River Commission has, under authorization of Congress, built an experimental station at Vicksburg where Mississippi River flood conditions will be reproduced on a small scale and intensively studied.

It is doubtful indeed whether, at the available site of the Bureau of Standards in Washington, there is either area or water supply sufficient to conduct the major experiments necessary for the determination of data used in the design of river and harbor works. Such experimental stations as the one at Memphis, now operated by the army engineers, will be needed for this. However, for use in connection with the individual small-scale model investigations—and also in the design of waterways and river projects for the development of hydro-power—there are fundamental hydraulic data to be secured and phenomena of flow to be explained. The finding of these and other fundamental hydraulic facts, the securing of which requires experimental conditions far beyond the financial capacity and opportunity of most individuals, will be among the valuable and important services of the national hydraulic laboratory.

The United States Reclamation Service has done some experimental work where opportunity was offered during the construction of its projects. The United States Geological survey accomplished something in the rating and determination of coefficients for meters and instruments for measuring river flow. There has been no co-ordination of these efforts, however, and no logical plan or means for combining them with other data in the most useful form. The proposed national hydraulic laboratory will meet this requirement.

It should be understood clearly by all concerned that the laboratory must not be regarded as an agency for conducting private or individual research in behalf of commercial organizations or private enterprise. There are ample hydraulic research and laboratory facilities among the leading universities and hydro power machinery manufacturers for that purpose. The national hydraulic laboratory, as stated in the bill which proposed it, shall be for the "determination of fundamental data useful in hydraulic research and engineering." In this category it will be able to do a boundless service to the people of the country and keep busy to its full capacity.

Caution Needed When Loading Electrical Equipment

SHORTER working hours and other causes that tend to reduce load factor have greatly increased the cost of power service per kilowatt-hour delivered. To counteract this condition an attempt is being made to work electrical equipment harder during heavy load periods. In this there is a possibility that the saving in initial investment may be offset by increased maintenance and loss in production.

Transformers are an important part of the cost of alternating-current transmission and distribution. As a means of reducing this, attention is being given to operation on the basis of maximum allowable temperature instead of nameplate rating. A proposed code for operating transformers on limited temperature rise was discussed at the recent winter convention of the American Institute of Electrical Engineers in New York City. The object of this code is to permit weighing the effect of the varying conditions under which equipment operates and to authorize greater capacity than indicated on the nameplate, when proper.

Transformers and other electrical equipment are sold on standard, guaranteed nameplate ratings. These are probably conservative. Few if any electrical machines are operated for long periods at their guaranteed winding temperatures. Usually these temperatures are approached only during short peak-load periods. At other times the loads are considerably below standard rated capacities. Just what effect operating any machine for years at its guaranteed temperature rating may have on the insulation is open to argument. So any plan to do this should be approached with caution, as suggested in the proposed operating code.

Improvements in design of electrical equipment and better means for determining safe operating temperatures have resulted in greater capacities per unit weight of material used. This has meant an increased capacity per dollar invested.

The cost of electrical equipment to supply a given load may be considered as made up of two items: the initial investment and the cost of keeping equipment in service. The latter item should include all expense incident to equipment failures. Electrical machinery may fail and be repaired at small cost, but the losses to revenue while out of service may be high. Consideration of equipment investment should be made with full appreciation for the value of reliability.

ROTARY CAR DUMPER
a Feature of
STATE LINE STATION

Automatically operated, it is 60 ft. long and has a capacity of twenty 120-ton cars per hour. The cars are pushed up the incline by an electrically operated mule, and on the decline are controlled by electric-pneumatic retarders

IN THE articles that have appeared recently in *Power* on State Line Station, space was not available to give more than passing mention to the coal-handling system, which has a number of features that are unusual in a power plant. Chief interest perhaps centers in a rotary railroad-car dumper of unusual size, and the auxiliary equipment employed to overcome the physical conditions imposed by the elevation of the dumper, such as an electrically operated mule to push the loaded cars up the incline and a retarder system under electric-pneumatic control to regulate the speed of the empty cars in their passage down the decline.

An idea of the operation of the dumper may be had by reference to Fig. 3, which shows the general design of a standard Link-Belt dumper of 50 ft. length. The installation at State Line is identical in main features, except that it is 10 ft. longer and has four instead of two top clamps to hold the railroad car in position, and four lever arms on the cradle connected with outside counterweights to hold the top clamps and support the overturned car and its load.

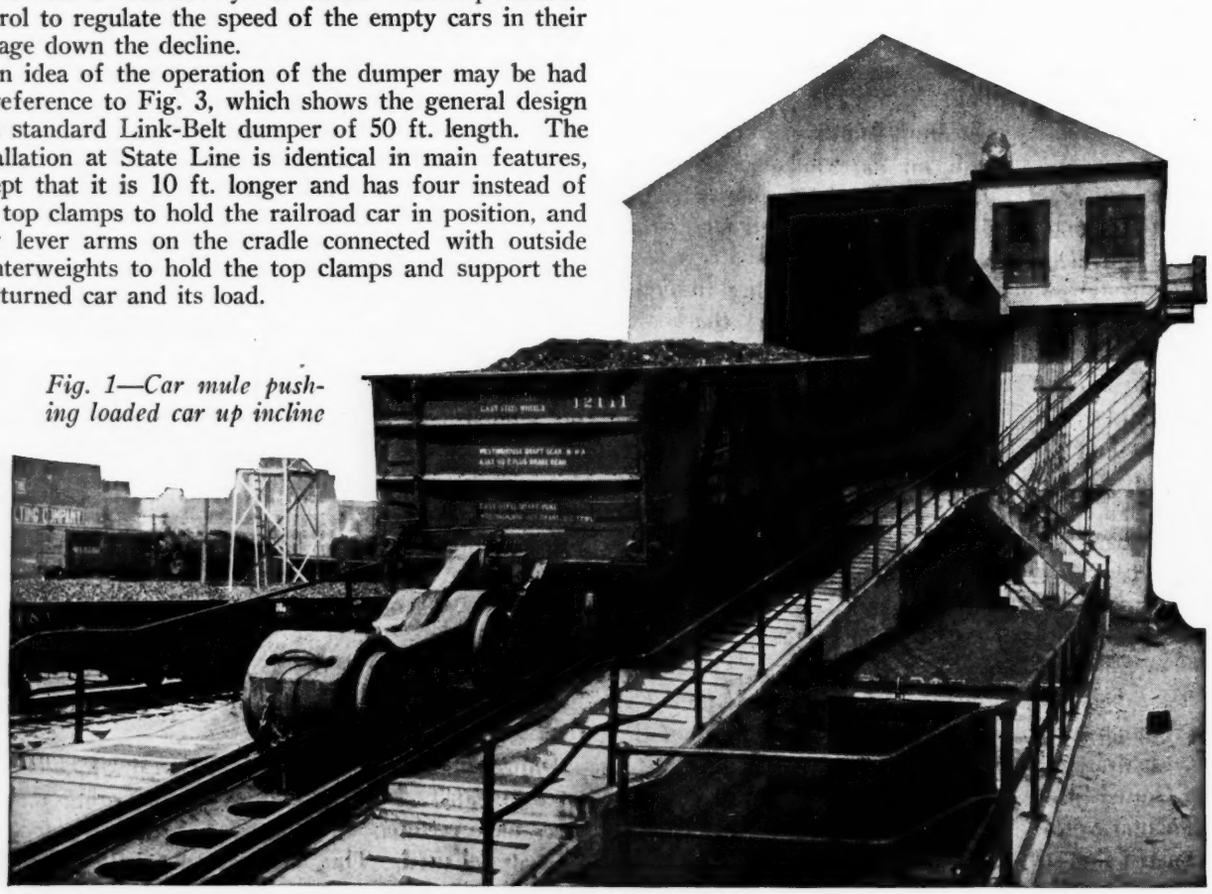


Fig. 1—Car mule pushing loaded car up incline

It will be seen that the dumper comprises two distinctly separate structures: the cradle, consisting of two structural steel end rings 26 ft. 6 in. in diameter that are rigidly interconnected and braced; and a spring-operated transfer table supported within the outer structure on transverse rollers and provided with rails on which the car rests. The entire cradle is supported and revolved on eight rollers arranged two in tandem at each corner and equalized. To insure alignment the two equalizing trucks at each end are on a common frame.

The dumper is revolved by two standard steel hoisting cables, one attached to each end ring, which are wound and unwound on grooved drums in line with the rings. Through cut steel spur gearing running in oil the drums are connected to the 45-hp. driving motor, the latter equipped with a solenoid brake for holding the dumper in any desired position when the current is off.

Four automatic gravity-operated top clamps are used for holding the overturned car in the cradle. Controlled by cables, the clamps move to the car by gravity at a

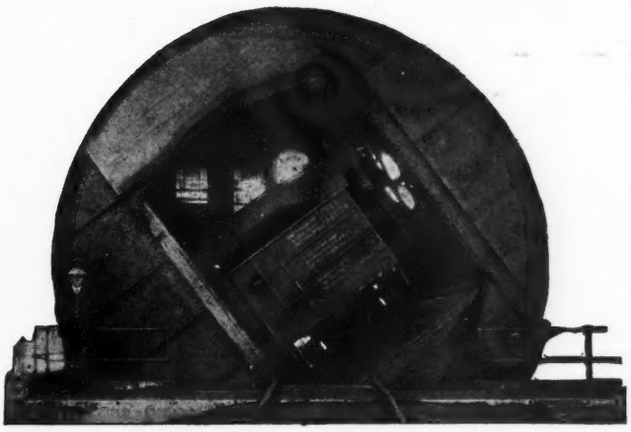


Fig. 2—Cradle of dumper revolving with loaded car

speed governed by the rotation of the dumper. At a predetermined point in the first few degrees of rotation the drums upon which the car-holding cables are wound are locked, and for further rotation the car is held in the cradle by counterweights external to the cradle. Four counterweights are connected by cables to the ends of the same number of powerful lever arms attached to the cradle. The holding power of the counterweights increases with the rotation of the dumper, becoming greatest at the maximum angle of tip. During the reverse rotation, as the dumper approaches its normal position, the holding drum brake releases and the clamps are raised through contact of a lifting carriage on the roller ring, providing ample clearance for the cars to pass through the dumper.

The operator controls the rotation of the dumper with a single lever, his location being in a cab at one end of the installation. The cycle of operation follows: Rotation begins, the spring-operated transfer table moves the car to its fixed side support, and the top clamps lower to the top of the car. With the car firmly held at the dumping side and clamped at the top, rotation continues until the motor is automatically stopped by a limit switch at the final dumping position, although the operator can stop at any intermediate position if he desires. Movement of the control lever in the opposite direction reverses the rotation, the top clamps automatically release and the transfer table moves the car back to its normal position, with the dumper rails in correct alignment with those on the inclines at the approaching and departing ends of the dumper.

With the exception of the manual operation of the control lever, all operations are automatic. Limit switches are provided to prevent overtravel in rotation of the cradle in either direction. The complete cycle of operation is performed by a single motor in 1½ min., giving ample time to unload 20 railroad cars per hour ranging in capacities up to 120 tons. A track scale weighs the loaded and the empty car while in the dumper, giving the net weight of fuel handled.

On the approach side of the dumper an interesting feature is the Wellman-Seaver-Morgan mule that pushes the loaded coal cars up a 15 per cent incline to the dumper, and the electrical equipment required to operate it. The mule operates on a track between the railroad rails. It passes under an incoming car through automatic gates into a trench at a lower level and comes up at the far side to push the car up the incline, which it was doing when the photograph reproduced in Fig. 1 was taken.

The mule is a heavy cast-steel frame carrying a push bar, the latter being supported by a pin at the rear end

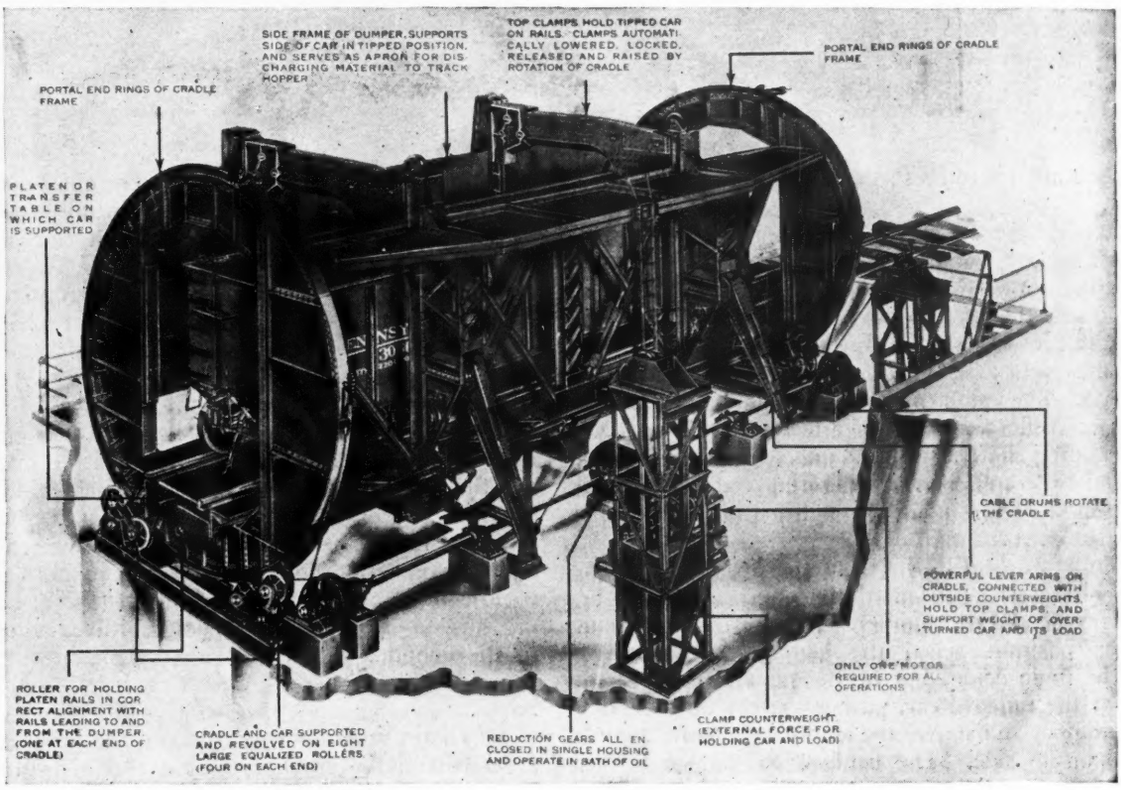

SIDE FRAME OF DUMPER, SUPPORTS SIDE OF CAR IN TIPPED POSITION, AND SERVES AS APRON FOR DISCHARGING MATERIAL TO TRACK HOPPER
TOP CLAMPS HOLD TIPPED CAR ON RAILS. CLAMPS AUTOMATICALLY LOWERED, LOCKED, RELEASED AND RAISED BY ROTATION OF CRADLE
PORTAL END RINGS OF CRADLE FRAME
PORTAL END RINGS OF CRADLE FRAME
PLATEN OR TRANSFER TABLE ON WHICH CAR IS SUPPORTED
CABLE DRUMS ROTATE THE CRADLE
POWERFUL LEVER ARMS ON CRADLE, CONNECTED WITH OUTSIDE COUNTERWEIGHTS, HOLD TOP CLAMPS, AND SUPPORT WEIGHT OF OVERTURNED CAR AND ITS LOAD
ONLY ONE MOTOR REQUIRED FOR ALL OPERATIONS
ROLLER FOR HOLDING PLATEN RAILS IN CORRECT ALIGNMENT WITH RAILS LEADING TO AND FROM THE DUMPER. (ONE AT EACH END OF CRADLE)
CRADLE AND CAR SUPPORTED AND REVOLVED ON EIGHT LARGE EQUALIZED ROLLERS. (FOUR ON EACH END)
REDUCTION GEARS ALL ENCLOSED IN SINGLE HOUSING AND OPERATE IN BATH OF OIL
CLAMP COUNTERWEIGHT (EXTERNAL FORCE FOR HOLDING CAR AND LOAD)

Fig. 3—Rotary car dumper similar to that installed at State Line

and flexibly by an eyebolt with spring mounting located near the center of the frame.

The haulage equipment consists of an 81¾-in.-pitch-diameter drum connected through a train of cut spur gears and one reduction of cut herringbone gears to a driving direct-current motor of 450-hp. capacity. The motor has a shaft extension on the commutator end on which to mount a solenoid brake, whose retarding torque may be adjusted up to 6,000 ft.-lb. The mule hoisting speed is 300 ft. per minute, and the lowering speed 400 ft. per minute. Energy is supplied through a 300-kw. motor-generator set consisting of a 2,300-volt synchronous motor and a 230-volt direct-current generator with a direct-connected exciter.

From the drum a 1⅝-in. haulage rope leads over a fleeting sheave in the approach supports and around the head sheave at the top of the incline, thence between the mule track rails down to the mule pit, where it is anchored to the mule. A ¾-in. tail rope leads in the opposite direction from the drum over deflecting and guide sheaves and around an inclined sheave at the far end of the mule pit to be fastened to the rear end of the mule car.

The upper bypass gate is situated part way up the incline. The lower gate is in front of the mule pit, beyond the bottom of the approach. The gates are pivotably mounted, the upper gate at its upper end and the lower gate at its lower end. Each is counterbalanced by a cast-iron weight assembled on a lever keyed to the gate hinge shaft. The gate is operated by a double mechanism consisting of rollers mounted on a heavy steel lever keyed to the operating shaft, which is connected to the operating mechanism by cranks and an operating rod. The crank is driven by a 7½-hp. motor through a train of cut spur gears and one worm unit.

Incoming cars lead down from the loading yard and come to rest at the bottom of the approach grade, between the mule and the dumper. The bypass gates being in proper position, when the haulage mechanism is started the mule comes out of the pit and engages the coupler of the railroad car, pushes the car up the grade into the dumper and shoves the empty car off the dumper on the opposite side. The haulage mechanism is then reversed to return the mule to the pit, and the positions of the gates also are reversed. The mule travels on the lower track back to the pit. This lower track extends from the upper gate to the back end of the mule pit and is of sufficient depth to permit the mule to pass under the car standing on the approach. In this way another car can be brought into position while the mule is returning to the pit.

One 450-hp. direct-current shunt-wound motor is required for car haulage, and two 7½-hp. series-wound motors for the bypass gates. All have solenoid brakes. Regulation is effected by the Ward Leonard system of field control, in which the field of the generator is regulated by the operator through a master switch in the operator's cab. Control of the bypass gates is automatic. Limit switches slow down the equipment when approaching final stop positions and when the mule is about to engage the loaded car. Other limit switches will stop the mule if the gates or the dumper cradle are not in position at its approach.

As the cars leave the dumper they pass down a 10 per cent decline. To keep them from attaining undue speed, some method of retardation other than the usual braking was necessary, so it was decided to install in series four double-rail retarders of Union Switch & Signal Company design such as are used in railroad yards, each actuated by an air cylinder electrically controlled from the base of the dumper. Thus each operates as a remote-controlled air-brake, with the brakes at either rail pressing against both sides of the car wheels.

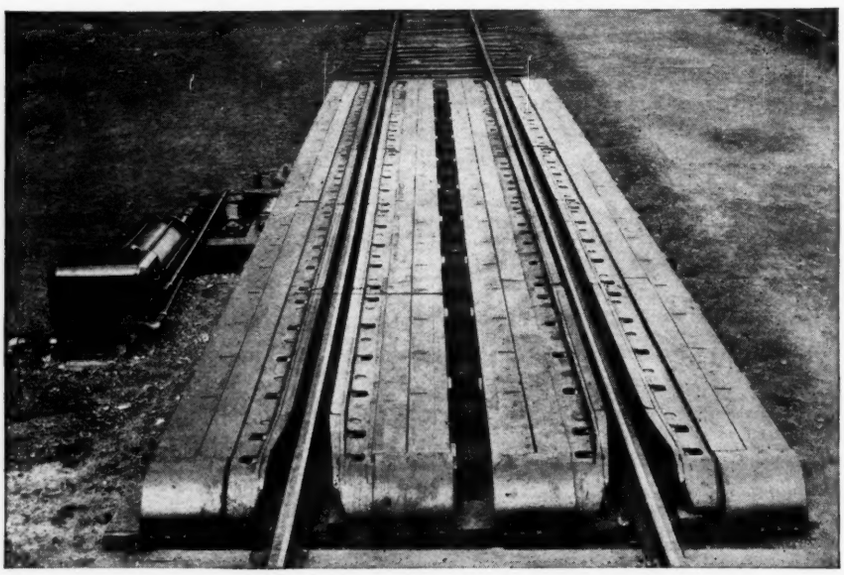


Fig. 4—Close-up of single double-rail retarder with air-operating cylinder at left

Four degrees of retardation are provided. In the first three the auxiliary piston has high-pressure air admitted behind it, limiting the stroke of the main piston, and the retarder will close to a gage of about 4¼ in. The difference in braking effectiveness for the first three positions is obtained by varying the air pressure on the main piston. Bourdon spring-type regulators with electrical contact points in the air supply system control the pressures and by solenoid-operated valves admit the air to the cylinder as dictated by the operator through a four-point controller or operating lever in the control house.

To obtain maximum retardation, the air is exhausted from behind the auxiliary piston and high-pressure air is admitted to the back of the main piston, thus driving

it to the end of the stroke and closing the retarder to its minimum gage, about 3⅞ in. Air is exhausted from the main chamber back of the main piston and admitted to the chamber back of the auxiliary piston and between it and the main piston to open the retarder. Fig. 5 is a diagram of the linkage between the air cylinder and the brake beams.

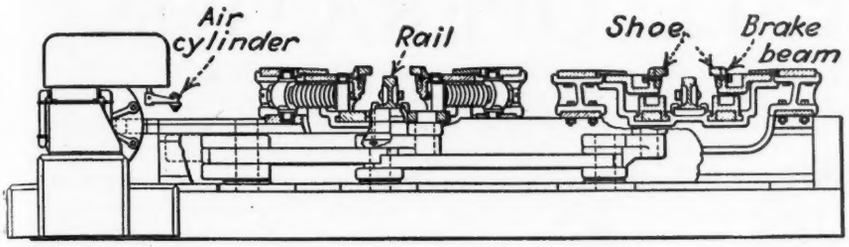


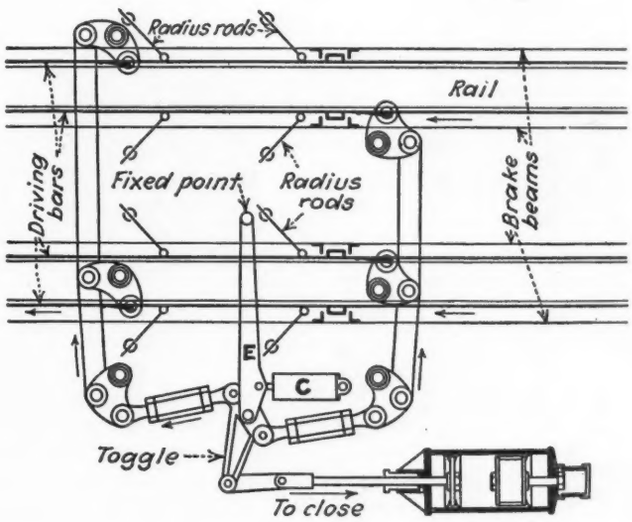
Fig. 5—Diagram of retarder linkage

Fig. 6—Transverse section of retarder

When a car enters the retarder the reaction of the two inside lines of brake shoe beams is opposed to the reaction of the two outside beams. This equalizes the pressure on the brake shoe beams and at the same time provides a centering force that maintains the center line of the truck over the center line of the track. Turnbuckles in the toggle connecting rods provide adjustments to compensate for normal brake shoe wear.

Articulated brake beams in five sections permit a weaving action as the car wheels go through. The beams are backed by radius rod assemblies on 22-in. spacing. Each assembly consists of a radius rod shaped to form a pin at the brake beam end; a helical coil spring to give resiliency; a self-locking radius rod nut that adjusts the length of the radius rod without affecting the spring, and, therefore, the position of the shoe with relation to the rail; and a spring adjusting nut and a trunnion supported at top and bottom. The radius rods are set at an angle to the brake beam and force the beam inward as the linkage from the air cylinder imparts an endwise motion to the beam.

At the entrance and exit of the retarder the brake beams are about a foot longer than the intermediate beams. Also, they are flared in a vertical direction and curved to form a ramp. The flare and the additional length of the beam provide a wide opening between shoes at both ends of the retarder, an angle of approach sufficient to give a smooth entrance condition, and standard gage (therefore maximum retardation starting from the end of the flared portion). The curved ramp raises dragging equipment that might otherwise be caught and also protects the retarder from derailed cars.



. . SELF-INTEREST . .

WITH ALL the wonderful changes wrought in our civilization in the last generation, the world remains fundamentally primitive in at least one respect. We still must eat.

The primordial urge to sustain life may be traced through all time. To be sure, we may call it by other names, but the fact remains.

What greater urge than to provide for one's family and one's self? This self-interest is found in everything, the altruists notwithstanding.

DIRECT BENEFIT to the individual is a sound reason for industry to moderize its power plants.

Cheaper power will reduce the cost of the manufactured product. Lower cost means more sales, increased profits and a greater prosperity.

No imagination is required to see that lower cost of power will result from plant betterments and analytical control in the boiler room, engine room and elsewhere. The ways are many and profitable.

. . *Think it over*

YOU CAN CHECK DIESEL OPERATION

By the Exhaust Temperature

AT LEAST 75 PER CENT of modern oil engines are fitted with exhaust pyrometers or thermometers. Unfortunately, these instruments generally are not being operated as they should—the engineer either places a blind faith in them or disregards them entirely. In spite of this situation there is no doubt that when properly used and interpreted exhaust-gas temperature readings can be relied upon to show how combustion is proceeding in the engine cylinders.

Slight variations in the readings from the several cylinders of an engine should not be taken as proof that the spray-valve timing needs adjustment. Furthermore, engines of different types show marked differences in the temperature readings at various loads, and one must know the characteristics of a particular engine if the pyrometer readings are to be of value.

In general, however, an engine of a given type will show temperature characteristics peculiar to that system. In Fig. 1 are four curves of exhaust temperatures plotted against loads. These are based on actual readings obtained from engines of each type shown. It will be seen that the exhaust temperature of the four-stroke-cycle air-injection Diesel is directly proportional to the load, the several points forming a straight line.

A four-stroke-cycle solid-injection, "common rail," or timed spray valve, engine develops a line that is curved, with the full-load temperature showing a higher value than the one-half and three-quarters load value would lead one to expect. This is due, no doubt, to the type of spray valve used on this engine. Probably the fuel charge was such that not all of it burned immediately upon injection, in which event after-burning and a high exhaust temperature would naturally follow. In spite of this, however, the full-load exhaust temperature is below that of the air-injection engine. This is due, in the main, to the greater weight of air per pound of oil burned, which reduces the temperature of the exhaust gas.

The two-stroke-cycle crankcase compression engine, a four-cylinder 480-hp. unit, has a curve that is much lower than those of the two engines already discussed. This is due, primarily, to a low mean effective pressure, which is a result of a large air-to-fuel ratio. Just why it should show such a steep inclination is debatable, probably because of late or after-burning heavy loads.

That the two-stroke-cycle engine has a lower temperature than have the other two engines is also due to the scavenging arrangement and to the fact the pyrometer does not indicate the actual temperature of the burnt gases resulting from the combustion of the fuel. When the piston uncovers the exhaust and scavenging ports, hot burnt gases sweep out and are followed immediately by a flow of scavenging air from the scavenging ports. The pyrometer then indicates a temperature that is the mean of the burnt-gas and scavenging-air temperatures.

The curve of the two-stroke-cycle engine with separate scavenging pump should not be taken as characteristic of that type of engine. The high temperatures at three-quarters and full load are undoubtedly caused by the condition of the fuel-spray nozzles. This engine should

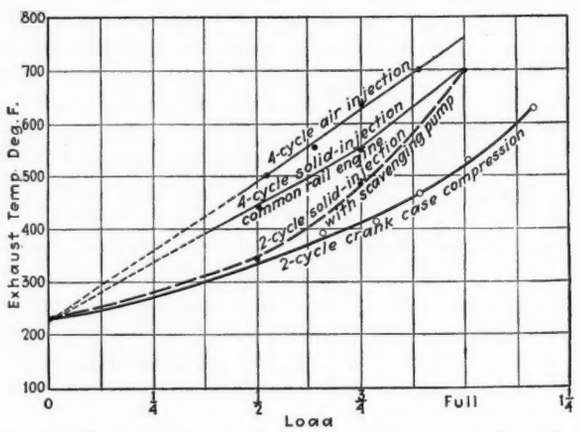


Fig. 1—Comparative exhaust temperatures of various types of engines

have a curve closely approximating that of the crankcase type.

Attention is called to the extensions of the curves to zero load. Apparently all four engines have a no-load exhaust temperature of about 230 deg. F. If the curves are extended to the left of the zero load curve to a point corresponding to zero indicated horsepower, the four-stroke-cycle engine shows an exhaust temperature of about 150 deg. F., which temperature would likewise be that in the cylinder at the beginning of compression, assuming adiabatic compression and expansion. On the other hand, the two-stroke-cycle solid-injection engine would have a zero indicated-horsepower exhaust temperature of about 200 deg. F. and a corresponding initial temperature, which is about the value to be expected. It appears from this that the exhaust temperature curve could be used to ascertain the weight of the cylinder air charge, without chemical analysis or complicated calculations.

The conclusion reached from the curves in Fig. 1 is that before using the exhaust temperature as an indica-

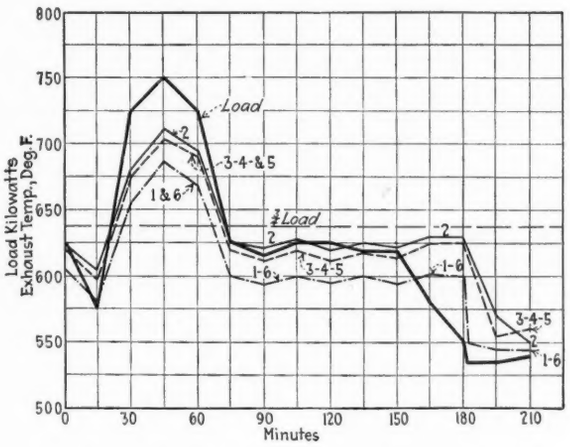


Fig. 2—Exhaust temperature changes plotted against time

tion of cylinder events, the engine's characteristics must be known.

The several cylinders of an engine should have exhaust temperatures of identical values. It is, however, difficult in some designs to prevent variations of from 10 to 30 deg. Usually this range is not objectionable. The several cylinders of large engines will show more uniformity than will those of small engines; because the fuel-spray valves of the large, slow-speed engines can be timed more closely.

In Fig. 2 are a series of readings taken from a 1,200-hp. six-cylinder four-stroke-cycle air-injection engine, running at 164 r.p.m. It will be seen that the temperatures vary with the load, but Nos. 1 and 6 cylinders show temperatures about 25 deg. under the other cylinders. Here the discharge valves of Nos. 1 and 6 fuel pumps leak a trifle and need regrinding. The variation does not indicate enough leakage to justify stopping the engine.

Sometimes the temperature of an engine's cylinders is not uniform and does not show consistency in its variations. For example, in Fig. 3 are shown the readings obtained from a two-cylinder 90-hp. four-stroke-cycle mechanical-injection engine. The temperatures of the two cylinders vary as much as 40 deg., although the load is fairly uniform. The inconsistency of the readings

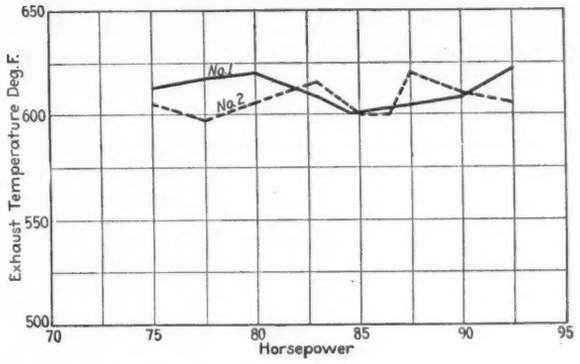


Fig. 3—Temperature variations due to governor linkage

is due to the governor mechanism. The travel of the two fuel-pump plungers is controlled by wedges and a linkage from the governor sleeve. Irregularities in the shape of the wedges and lost motion in the linkage cause erratic fuel charges.

Similar behavior of a four-stroke cycle "common-rail," or timed-needle-valve, solid-injection engine is shown in Fig. 4. The four cylinders failed to give consistent readings over the load range. In this instance, the needles of the spray valves were actuated by rockers and push rods, and the governor, by shifting a wedge in the bottom of each rod, altered the valve lift. The temperature variations were due to the governor mechanism. An engineer should not become excited when he finds a similar condition in an engine of this design.

The engine speed also has an influence upon the exhaust temperature. For two reasons: The higher speed gives less time for heat to flow to the cylinder walls, consequently raising the exhaust temperature. Of more importance is the handicapped combustion at high speeds. The time interval of ignition and combustion is so short

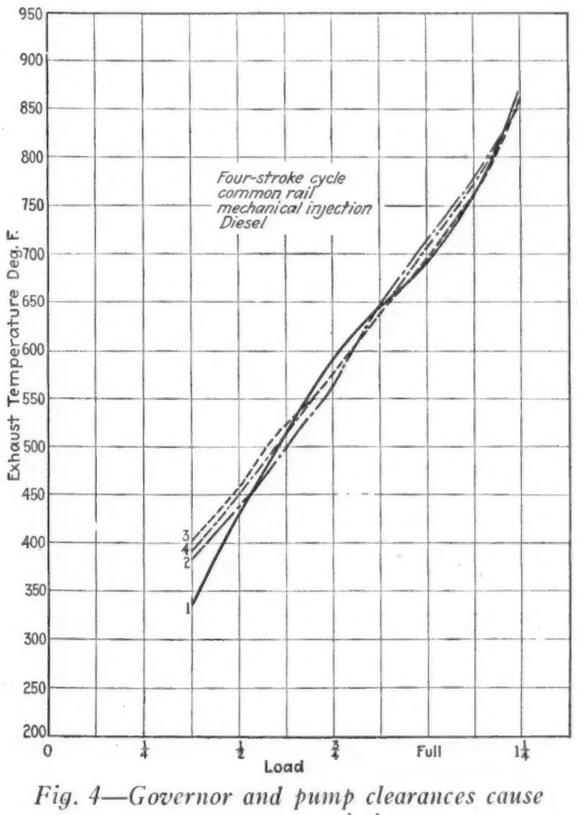


Fig. 4—Governor and pump clearances cause temperature variations

that burning may continue until the end of the stroke.

One of the two charts reproduced in Fig. 5 was developed by E. G. Magdeburger, and the other by M. L. Maleev. It will be seen that with both the "common

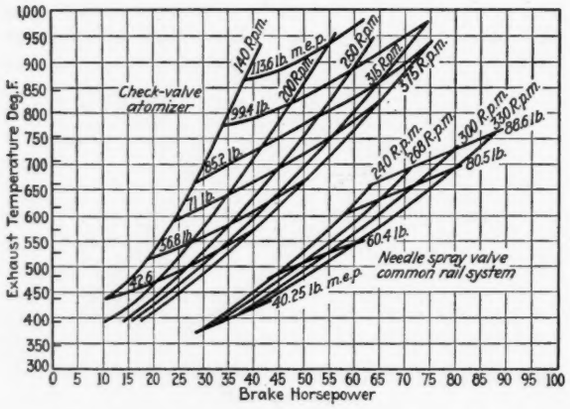


Fig. 5—Temperature variations with speed and load of two mechanical-injection Diesels

rail" and the check-valve atomizer engine the exhaust temperatures increase with the load, but that at a given mean effective pressure and speed the temperature readings from the two engines are not the same. For example, at 315 r.p.m. and 85.2 lb. mean effective pressure, the engine with the check-valve atomizer has an exhaust temperature of 850 deg. F., while the common-rail engine at 300 r.p.m. and 85 lb. mean effective pressure shows approximately 700 deg. F. exhaust temperature. A marked difference exists at all loads.

The proposition has been advanced that the engine builder should test an engine of a given size and supply a series of curves to the purchaser of any other engine of the same dimensions and type. With this before him the engineer could tell if he was obtaining reasonable results in fuel consumption.

A similar set of curves from a two-stroke-cycle solid-injection Diesel is shown in Fig. 6. With this engine

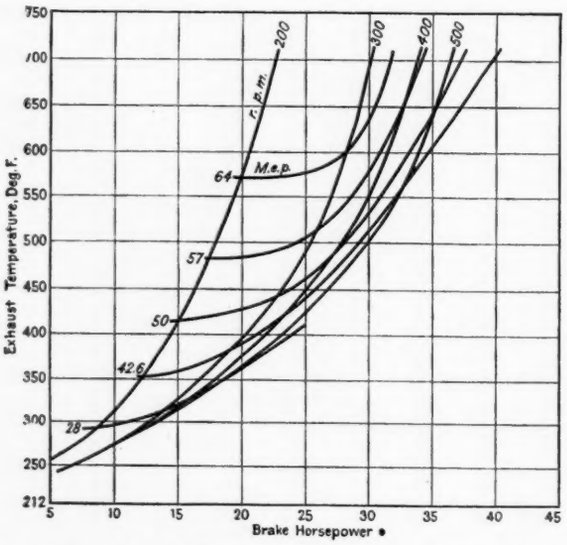


Fig. 6—Results obtained from a two-stroke-cycle engine

the maximum mean effective pressure is 64 lb. and the limiting temperature 700 deg. F.

The conclusion to be drawn from the several sets of temperature readings is that the exhaust pyrometer is a necessary adjunct to any engine, and hourly readings should be taken and set down in the plant log. But the operator should not allow a difference of 10 to 20 deg. in the readings from the several cylinders to cause him to adjust the fuel pump or valves. He must remember that the error may be in the pyrometer itself, for if the terminal in the exhaust connection becomes coated with soot, the reading from that cylinder will be low because of the insulating effect of the carbon.

Making Connections to Power Apparatus

By Emil G. Bern
Switchgear Department
General Electric Company

TO SELECT the material and cross-section for a power circuit on the basis of permissible temperature rise or voltage drop at ordinary loads is only part of connecting power apparatus in a modern plant. Both normal and abnormal conditions must be considered, and it is usually an economic question as to the cost justified for insurance against a possible disaster.

Present-day power apparatus is fairly well identified by ratings for various conditions. Limitations of connections, whether made with rectangular bars, tubes or cables are also quite well known under conditions of normal operation. For abnormal currents of different time duration these limitations have probably not been quite so well established. Connection joints between cables and equipment are often not given proper attention and are the source of serious trouble.

About the same problem exists in the joint between the connecting conductors and apparatus, whether it is made with a bar or with a terminal lug soldered to a cable end, except for the effect of heat on the soldered joint. In either case high pressure must be maintained between clean contact surfaces of reasonable cross-section, if trouble is to be avoided. One of the first considerations is to have contact surfaces of adequate size. Many rules have been advocated for determining what this should be, but when verified by experience, they have proved of less consequence than keeping the joints under high pressure.

While a large contact surface is generally desirable, there are many cases where small surfaces are used under high pressures. The whole problem may be reduced to maintaining a low resistance, whether the contact be a surface, a line or a point. The higher the pressure, the easier it should be to keep out the oxidizing influence of the atmosphere. Assume a contact of such small dimension that the current overheats the cross-section of the metal forming the joint. The high temperature will oxidize the contact points and will produce additional resistance, with accumulated heating and oxidizing. Sometimes large surfaces offer the advantages of excluding the oxidizing air, either by filling accidentally with foreign matter or by placing substances between the surfaces to exclude the air. For this reason, vaseline, sometimes paint, is used on the contact surfaces before they are bolted together.

To maintain a high pressure on a joint is often difficult, because of the expansion and contraction of the current-

carrying parts produced by temperature changes that fluctuate with the current. The joint bolts usually do not carry much current, remaining more constant in temperature than the rest of the metals. The joint pressure, therefore, increases with the current. This would be an ideal condition were it not that the pressure on the joint may be reduced by the bolts or the conductor taking a permanent set. When this happens air is admitted to the joint and causes the surfaces to oxidize. The possibilities of the joint becoming loose increase with its thickness, the current fluctuations and the temperature coefficient of expansion of the material in the bolts and the conductors. The lineal expansion per degree Centigrade of some of the most common metals used in electric circuits are: copper, 0.000016; aluminum, 0.000022; zinc, 0.000025; and steel, 0.000012.

Unfortunately, the importance of a good joint is not generally recognized and often a mystery exists as to why certain parts of power plant equipment overheat even under normal conditions. The answer to this is the same as why many fuses blow without apparent cause; namely, poor joints.

The melting point of copper is usually given as 1,083 deg. C., which is, therefore, the highest temperature that can be considered. In many cases the copper will disintegrate at lower temperature when united with metals of lower melting point, like solder, and in particular when subjected to comparatively slow heating, heavy magnetic stresses and vibration.

Unless cable lugs of special design are applied, it is not advisable to permit a temperature higher than the melting point of the solder used in joining the lugs to the cable. The melting point is different for the various compositions of solder, but it is customary to use an alloy of half tin and half lead. Such a solder has a melting point just below 200 deg. C. This composition, however, becomes plastic at about 150 deg. C., which should be considered the maximum permissible temperature for any ordinary soldered joint.

Table I gives the amount of current required to raise the temperature from 70 to 150 deg. in a given time.

TABLE I—APPROXIMATE CURRENT REQUIRED TO RAISE THE TEMPERATURE IN COPPER CONDUCTORS FROM 70 TO 150 DEG. C. IN A GIVEN TIME

Time, seconds	0.1	0.5	1.0	3.0	5.0
Amp. per circ. mil	0.1755	0.0785	0.0555	0.0320	0.0248
Amp. per sq.mil	0.2235	0.1000	0.0706	0.0407	0.0316
No. 12 A.W.G.	1,145	512	362	209	161
No. 8 A.W.G.	2,900	1,295	916	528	410
No 0 A.W.G.	18,530	8,280	5,860	3,370	2,620
No. 0000 A.W.G.	37,100	16,580	11,720	6,760	5,240
500,000 circ. mil	87,800	39,300	27,750	16,000	12,400
750,000 circ.mil	131,500	58,900	41,600	24,000	18,600
1,000,000 circ.mil	175,500	78,500	55,500	32,000	24,800
1,500,000 circ.mil	263,500	117,600	83,100	47,900	37,200
2,000,000 circ.mil	357,000	157,000	111,000	64,000	49,600

When a cable is running at a temperature rise of 30 deg. C. over an ambient temperature of 40 deg. and is suddenly subjected to a heavy overload, this table has been calculated by disregarding radiation and on the basis that resistance of 1 c.c. of copper at 0 deg. equals 1.589 microhms, and for a temperature coefficient of 1/234 at 0 deg. To use the table find the size of wire in the left-hand column and read the current, in amperes, under time. For example, a No. 0 wire operating at 70 deg. will have its temperature raised to 150 deg. by a current of 5,820 amp. in 1 sec., and by 3,370 amp. in three seconds.

The current values given in Table I should be considered maximum for ordinary heavy duty soldered lugs. This type is so designed that in normal operation its temperature will be less than that of the maximum size of cable to which it can be soldered. Care must be used in the installation of lugs to protect against stresses being produced by magnetic action or gravity.

A cable lug can be proportioned so that a temperature caused by a current of sufficient value to melt the cable will not unsolder the lug within a time period short enough to justify disregarding radiation. Calculations verified by several tests have proved the practicability of such a construction, which is now available as an extra-heavy-duty terminal for cable. On the same basis as that on which Table I was prepared, Table II shows the current required to raise the temperature in copper conductors from 70 to 1,083 deg.C., the melting point of copper. In this table the current values are more than double those in Table I, which are based on a safe temperature for ordinary heavy-duty soldered terminals.

TABLE II—APPROXIMATE CURRENT REQUIRED TO RAISE THE TEMPERATURE OF COPPER CONDUCTORS FROM 70 TO 1,083 DEG. C. IN A GIVEN TIME

Time, seconds	0.1	0.5	1.0	3.0	5.0
Amp. per circ.mil	0.439	0.1965	0.1390	0.0804	0.0621
Amp. per sq.mil	0.556	0.2505	0.1770	0.1023	0.0791
No. 12 A.W.G.	2,870	1,281	906	525	405
No. 8 A.W.G.	7,250	3,250	2,295	1,328	1,025
No. 0 A.W.G.	46,300	20,700	14,650	8,480	6,550
No. 0000 A.W.G.	92,800	41,600	29,400	17,000	13,100
500,000 circ.mil	219,500	98,200	69,500	40,200	31,500
750,000 circ.mil	329,000	147,100	104,100	60,300	46,600
1,000,000 circ.mil	439,000	196,500	139,000	80,400	62,100
1,500,000 circ.mil	658,000	295,000	208,500	120,500	93,100
2,000,000 circ.mil	878,000	393,000	278,000	160,600	124,200

The work of soldering cable lugs and the proportion of the contact surface between the lug and its block are not always given proper attention. Practically all ordinary failures of cable lugs have their origin in one or both of these causes. The seriousness of the situation is augmented by the fact that poor workmanship is difficult or impossible to detect after completion of the installation.

German Progress in Coal Byproducts

DIRECT LIQUEFACTION of lignite and coal is now on a comparatively mass-scale production in Germany, according to the Chemical Division of the United States Department of Commerce. The dye trust probably produced 50,000 metric tons of gasoline from lignite in 1928, and is now operating about 300 tons daily, or at a rate of 100,000 tons annually. Along with milled lignite as raw material, increasing quantities of lignite tar and generator tars are being supplied as one of the raw materials. Hydrogen for catalytic saturation of this material is obtained from water gas produced over coke.

A plant at Duisburg-Meiderich using low-grade coal as raw material for its hydrogenation is said to have a capacity for consumption of 30,000 tons coal annually, which, if yielding 50 per cent weight-basis oil, would mean an output of 15,000 tons annually. It gets its hydrogen from partial separation of hydrogen by coke-oven gas condensation, requiring a supply of 50 million cubic meters of coke-oven gas annually.

The tremendous economic importance of making synthetic oil in Germany can be appreciated when it is considered that this country imported in 1928 more than 800,000 metric tons of light oils, more than 300,000 tons of motor oils, and more than 500,000 tons of lubricating oils.

CHART FOR FEED HEATING

By C. A. GRIFFITHS
Lieutenant, U. S. Navy

Maintenance of proper feedwater temperature requires the co-operation of the boiler-room operating force. The men on the job can be taught to use the chart here presented. With its aid they will gain a new appreciation of the importance of constant attention to the temperature of the feed water.

THE important effect of a high feed-water temperature on the economy of a steam boiler plant is well known, yet the calculations necessary to determine the amount of this saving are rarely undertaken by the operating engineer.

High feed temperature becomes increasingly important with higher steam pressures and superheated steam. To attain higher feed temperatures in the modern high-pressure high-temperature plants various devices are employed, such as bleeding partially worked steam from the lower stages of the turbine, the use of high-pressure closed feed-water heaters, and steam economizers utilizing the exhaust heat of the gases of combustion of the boilers.

The saving in heat can be calculated from the temperature of the feed water and the heat of the steam in the boilers. Thus, in a boiler having absolute steam pressure of 275 lb. per square inch, and 140 deg. superheat, the total heat of the steam above 32 deg. is approximately 1,286 B.t.u. per pound. Above zero deg.[1] this will become 1,318 B.t.u. per pound of steam.

If the boiler were fed directly from the feed tank at a temperature of 60 deg., say, then, of the total heat of the steam referred to zero degrees, 60 B.t.u. were put into it by the heat of the water. The heat then imparted to the steam by the gases of combustion in the boiler amounts to 1,318 less 60, or 1,258 B.t.u. per pound.

If, instead of being pumped directly from the feed tank to the boilers, the feed first is passed through a low-pressure feed-water heater and raised to a temperature of, say, 200 deg., then through a high-pressure heater where it is raised to a final temperature of 270 deg. the heat then imparted to the steam by the boilers becomes 1,318 less 270, or 1,048 B.t.u. per pound. As the heat given to the steam in this case is considerably less than that given in the former case, the quantity of fuel necessary to derive the same result will be less, and a corresponding saving will result. This saving amounts to a net gain of (270 — 60), or 210 B.t.u. per pound of steam, which, expressed as a percentage, becomes

$$\frac{210}{1{,}258} \times 100 = 16.7 \text{ per cent.}$$

[1]This assumes that water remains a liquid down to 0 deg. While not actually the case, this assumption does not introduce any error into the steam calculations—EDITOR.]

In a plant of 5,000 hp., at a steam rate of 15 lb. per shaft horsepower-hour, 75,000 lb. of water will be evaporated per hour. If a saving of 210 B.t.u. per pound can be effected by heating the feed water as described above with stage heating, the saving in the heat of the steam per hour will amount to 15,750,000 B.t.u. At a boiler efficiency of 75 per cent this would be the equivalent of 21,000,000 B.t.u. saved in the fuel; and at 19,000 B.t.u. per pound of fuel oil, this would amount to approximately three and one-half barrels of fuel oil saved per hour. From this quantity saved must be deducted the fuel equivalent of the work remaining in the steam which is used to heat the feed, a part of the energy of which might be otherwise utilized.

The saving in heat, expressed as a percentage of the total becomes: Percent saving $= 100 \times \frac{(T - t)}{(H + 32 - t)}$

Where: T = Final temperature of the feed.
t = Initial temperature of the feed.
H = Total heat of the steam (including superheat) above 32 deg. at boiler pressure and temperature.

The accompanying chart is a graphical solution of this equation for saturated and superheated steam conditions. It is composed of four squares and is used as follows:

HOW THE CHART IS USED

Enter square I, the lower left, from the bottom with the boiler pressure as read by gage. Project vertically upward to the curve representing the steam condition, dry saturated or superheated, thence from the intersection project a line horizontally to the right into square II. Enter square II from the bottom with the initial feed water temperature t and project vertically upward to the intersection with the horizontal line from square I. From this intersection follow the diagonal lines shown into square IV.

With the same initial feed-water temperature t enter square III from the top, project vertically downward to the line corresponding to the final temperature T. From that intersection project horizontally across the chart into square IV. The intersection in square IV of this horizontal line from square III with the vertical line

from square II will give the percentage of saving due to increasing the feed water temperature from t to T. In order not to confuse by too many finely spaced lines the chart has been prepared for only 50 unit temperature and pressure increments and even-numbered percentages. Interpolation will generally be necessary.

The solution of one problem is shown on the chart in dotted lines, the assumed conditions being:

Initial temperature t	= 60 deg.
Final temperature T	= 270 deg.
Boiler steam pressure	= 300 lb. gage.
Superheat	= 125 deg.

While the results from this chart may lack the exactitude of mathematical calculation, still they are sufficiently accurate for practical purposes and may serve to illustrate to the less experienced fireman or water tender the absolute necessity for high feed-water temperature, and thus encourage him to maintain a high, steady, feed temperature at all times. The average water tender, more practical than theoretical, will gaze with awe while the engineer in charge of the watch patiently demonstrates, by calculating, the savings that will accrue by maintaining a high feed temperature, whereas, given the chart to work himself, he can read the temperatures and pressures from instruments he knows and pick off the answer.

The more the practical benefits of sound engineering practice are instilled into the men in the plant, the greater will be their co-operation and the better the overall economy. And there exists no better means to demonstrate these benefits than by the use of a chart, the elements of which are readily apparent.

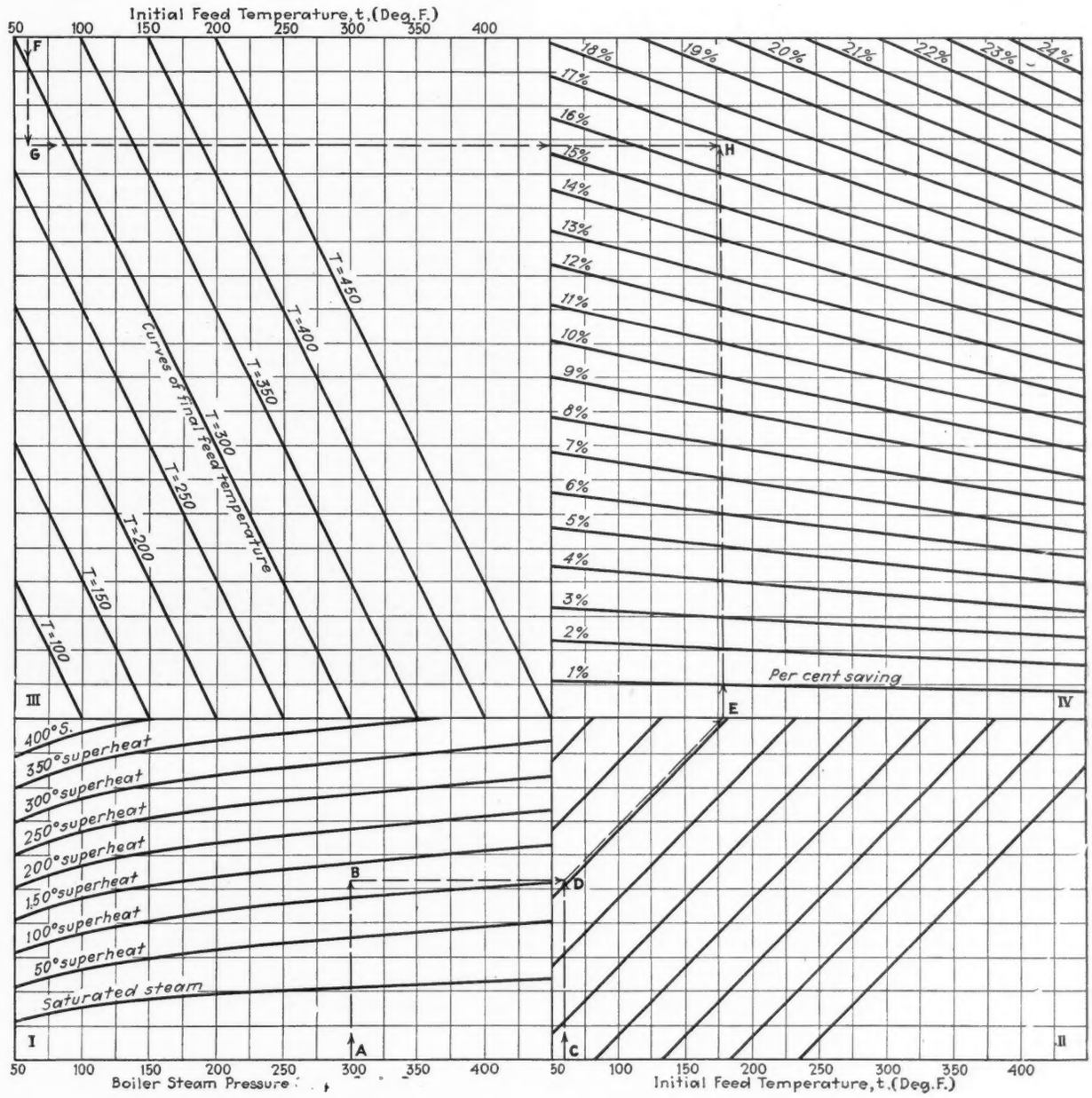


Chart for calculating per cent saving due to heating boiler-feed water

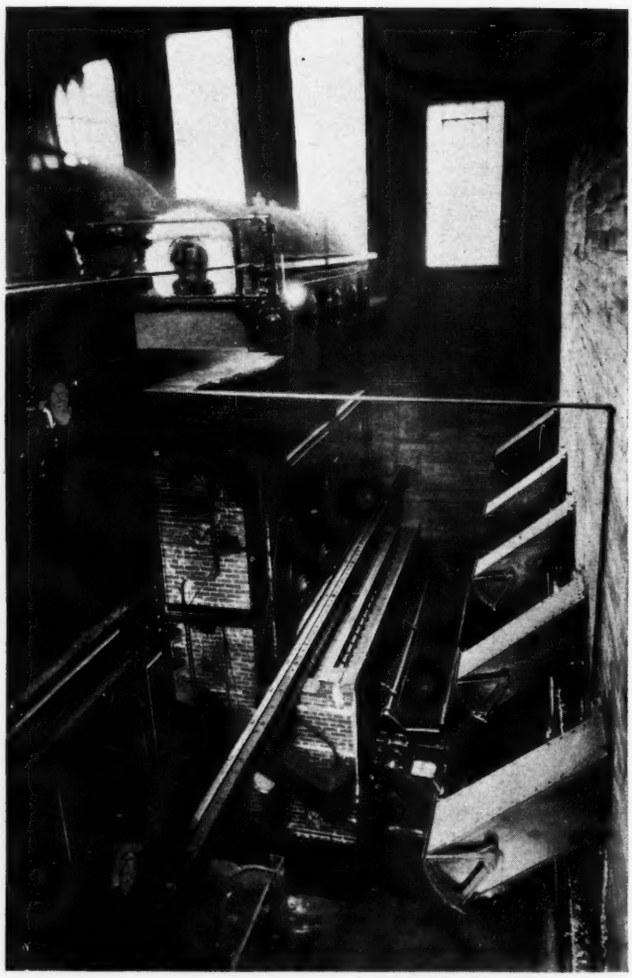
Designed by Lieutenant C. A. Griffiths, U. S. Navy

Improved Operation

Accompanies Growth of Plant and Load

◆

Creditable record made by Crawfordsville, Ind., municipal plant, which since its installation in 1891 has been periodically revamped to keep abreast of modern practice



View in boiler room showing method of delivering coal from bunker

ECONOMY of operation as the plant has been expanded to meet a growing load, and high net income on a rising curve, obtained from moderate rates, is the record of the Crawfordsville Electric Light & Power Company, serving Crawfordsville, Ind., and vicinity.

From a simple beginning in 1891, with two 1,500-sq.ft. Stirling-type boilers delivering steam at 100-lb. pressure and equipped with hand-operated Roney stokers; and two vertical engines belted to an alternator and an arc machine—the plant has grown gradually with the electric light and power industry. In 1892 it was necessary to install a 200-kw. engine-driven alternator, and a change in fuel was made from coal to natural gas, which was used until the supply became inadequate.

Growing demand led to the installation of a new plant, with turbine-generators and more modern boiler room equipment. The station was located on Sugar Creek, north of the city, where an ample supply of condensing water was available and coal could be delivered by gravity from the railway car into an outdoor concrete storage

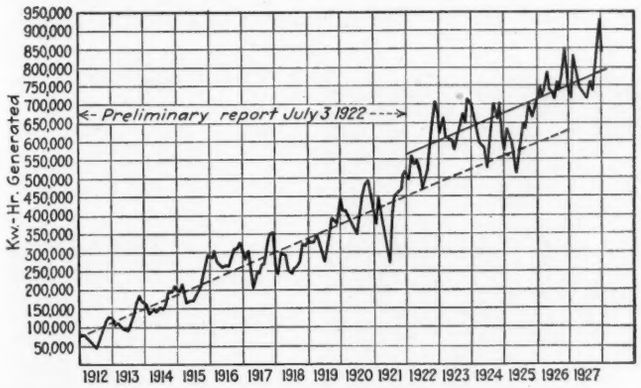
TABLE I.—SUMMARY OF OPERATING RESULTS AND NET PROFITS DATING FROM 1925

	Kw.-Hr. Generated	Net Kw.-Hr. Output	Coal Consumption, Tons	Coal, Lb. per Kw.-Hr. Generated	Total Water Evap. Lb.	Water per Kw.-Hr. Gen., Lb.	Water Evap. F. and A. 212 Deg. per Lb. Coal, Lb.	Total Revenues	Operating Expenses	Bond Interest	Total Operating Expenses	Net Profit
1925.....	7,579,638	6,107,956	12,923	3.40	161,104,580	21.30	7.15	$195,227.07	$116,791.06	$7,845.00	$124,636.06	$70,591.01
1926.....	8,499,580	6,673,606	13,334	3.14	168,628,500	19.94	7.30	215,607.23	110,665.86	7,487.50	118,153.36	97,453.87
1927.....	9,365,400	7,469,776	13,742	2.93	171,139,800	18.32	7.19	235,460.16	115,810.53	7,130.00	122,948.33	112,511.63
1928.....	10,091,520	8,237,042	14,803	2.93	184,524,000	18.39	7.05	258,213.26	121,910.38	6,772.50	128,682.88	129,530.38
1929 (6 mos.).	5,429,120	.....	7,651	2.81	101,474,100	18.68	7.79	146,305.75	58,424.94	3,207.48	61,632.42	84,673.33

bunker. The property adjoins the tracks of the Momon Railroad, situated at a higher level, and a railroad switch line is constructed over the bunker, so that gondola cars may be dumped directly into the coal-storage space, from which it flows by gravity into a traveling weigh larry serving the boilers.

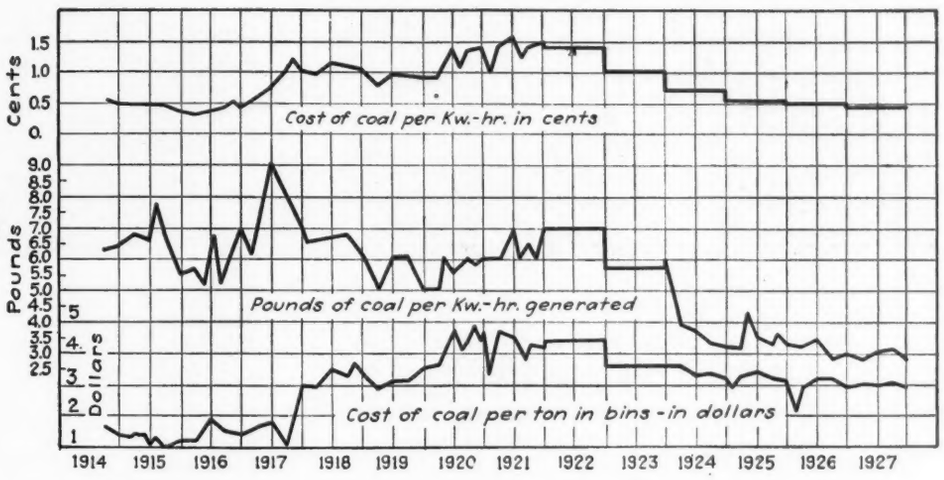
The original power plant was equipped with two 500-kw. turbine-generators served by jet condensers and three 3,500-sq.ft. Stirling-type water-tube boilers with Roney stokers. In 1914 another 3,500-sq.ft. boiler of the same type was added. In 1919 the electrical generating capacity was increased by the installation of a 1,500-kw. turbine-generator with a jet condenser. During that year the Roney stokers were replaced by underfeed units.

Continued increase in the demand for light and power made it evident that additional capacity would soon be needed, so in 1922 a careful study was made of the requirements and of the probable future demand. The immediate result of the survey was the installation of a 3,750-kw. turbine generator, a 6,000-sq.ft. surface condenser, a 7,790-sq.ft. Stirling-type boiler equipped with a forced-draft chain grate, and a 200-ft. brick stack.

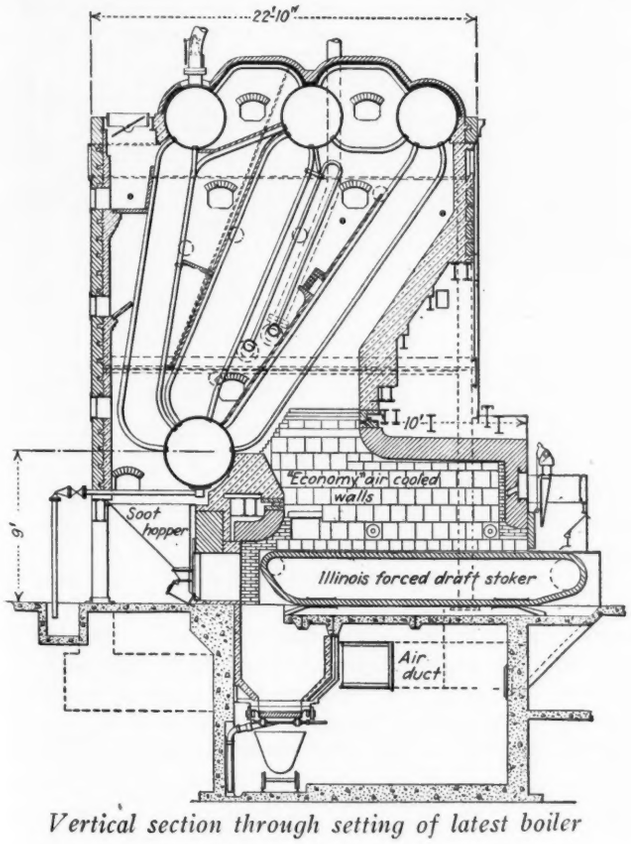


Monthly kilowatt-hours generated from 1912 to 1928

Coal cost curves from 1914 to 1928



Vertical section through setting of latest boiler



Vertical section through setting of latest boiler

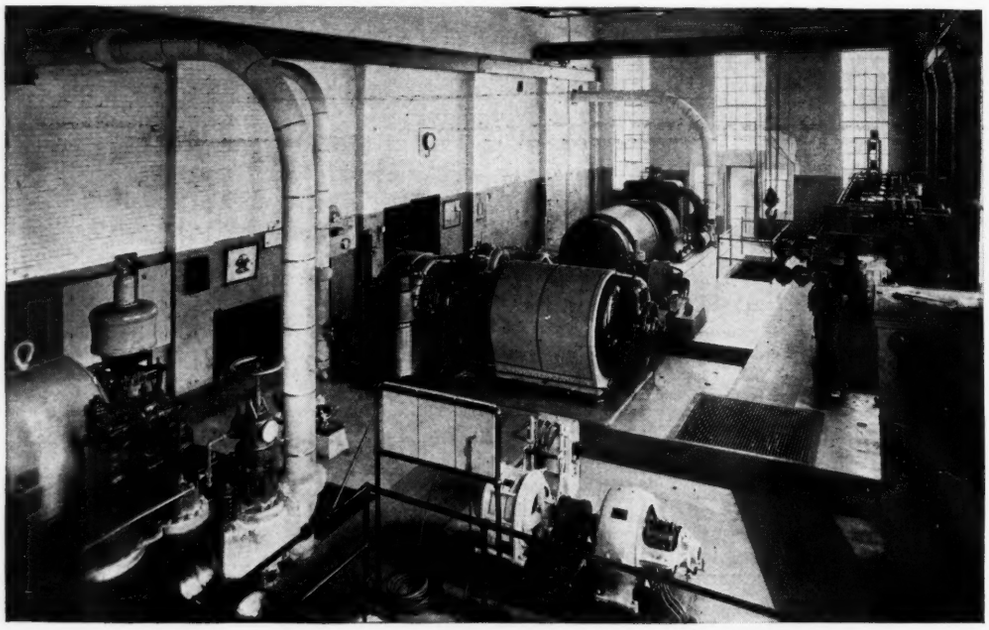
With each succeeding addition more modern than its predecessor, the plant has been kept reasonably up to date, with considerable improvement in economy. Acceptance tests on the new equipment installed in 1924 showed for the boiler an equivalent evaporation of 9.12 lb. per pound of dry 1½-in. Illinois screenings, 76.4 per cent efficiency for boiler, furnace and grate. The moisture in the coal averaged about 14 per cent, the ash over 18 per cent, and the calorific value per pound of dry coal 11,577 B.t.u. Consumption of steam by the turbine averaged 15.89 lb. per kilowatt-hour, and the dry coal per kilowatt-hour averaged 2.87 pounds.

This equipment reduced operating costs to a satisfactory figure, as shown in the accompanying curves and tables. At the same time it provided ample capacity for carrying any load to be encountered for some time to come. However, after four years' operation, the question of spare units became important, so there has just been installed another Stirling boiler with 8,500 sq.ft. of surface, fitted with an Illinois forced-draft chain grate, a 3,500-kw. turbine-generator and surface condenser replacing the two original 500-kw. units.

The two boilers last installed were designed for continuous operation at 250 per cent rating and for generation of steam at 225 lb. pressure and 100 deg. F. superheat. A section of the setting of the latest boiler is shown. Features of the setting are the 10-ft. combustion arch (insert from the front wall as indicated) and the spinal

air-cooled wall around the furnace that discharges preheated air over the fire at the front of the furnace.

These walls have three times as much heat-dissipating surface as they have heat-absorbing surface, so that wall temperature is maintained several hundred degrees lower than furnace temperature, with the resulting advantage in upkeep. Air from the forced-draft supply is introduced at the bottom of the wall to pass upward through tortuous, vertical passages within the blocks to a collecting duct at the top. This duct leads to a channel across the furnace front, from which the air at 450 deg. F. is jetted into the furnace at intervals.



This well-lighted turbine room reflects the up-to-date spirit that has made for efficient operation of the Crawfordsville plant

Reference to the accompanying charts will show the growth of the business and the improvements in results obtained notwithstanding the much higher cost of coal. In the survey[1] made in 1922 to anticipate future demands, prediction was made that the peak load for 1927 would be 2,500 kw. The chart shows the peak-load curve for the years 1912 to 1928, and the dotted line the average. Extension of the dotted line from 1922 intersects the curve exactly at the 2,500 kw. predicted for 1927.

In the same way the curve of monthly kilowtt-hours generated was drawn in 1922 and projected to 1927. From 1911 to 1922 the average monthly increase in kilowatt-hours was 3,300 per month. This is shown by the dotted line averaging the results given in the curve. The extension of the dotted line from 1922 does not represent the average monthly load, owing to a sudden increase in the industrial demand, which raised the monthly average to a higher level. The increase, however, has been at about the same rate, of 3,300 kw.-hr. per month, as shown by the averaging full line from 1922 on. Fuel consumption per kilowatt-hour has decreased gradually from a maximum of 7 lb. to a minimum of 2.8 lb. at the present time. Installation of the new equipment made since the survey has resulted in reducing the fuel consumption more than one-half, so that the cost of coal per kilowatt-hour is less at the present time than it was in 1914, notwithstanding the much higher price per ton.

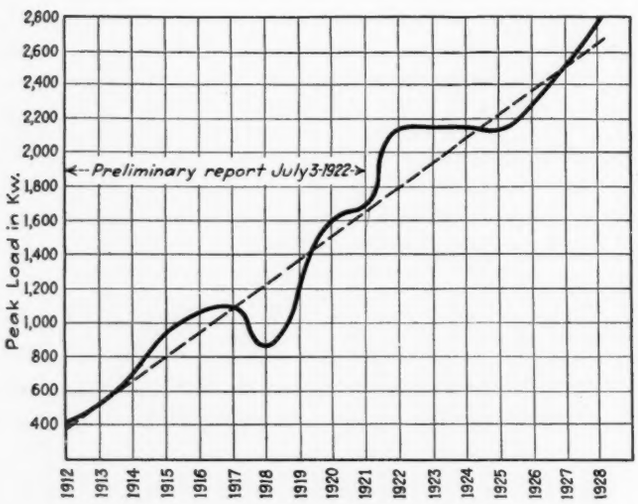
Perhaps the most interesting period dates from 1925 up to the latest records available. At the beginning of this period the improved plant was in operation and had showed considerable gain over past records. In 1926 the management was taken over by Earl Berry, assisted by Floyd McClelland, chief engineer of the generating plant. Improvement continued at an accelerated rate, as reference to Table I will show.

TABLE II.—UNIT COSTS OVER FOUR-YEAR PERIOD

	1925	1926	1927	1928
Kw.-hr. sold	6,107,956	6,673,606	7,469,776	8,237,042
Operating revenues	.....	$0.0316	$0.0304	$0.0302
Operating expenses:				
Power	.....	0.0108	0.0090	0.0091
Distribution	.....	0.0017	0.0020	0.0018
Consumption	.....	0.0003	0.0004	0.0003
Commercial	.....	0.0005	0.0004	0.0004
General	.....	0.0010	0.0014	0.0012
Undistributed	.....	0.0006	0.0007	0.0005
Total	.....	$0.0149	$0.0139	$.0133
Depreciation	.....	0.0018	0.0016	0.0015
Total operating expenses	$0.0191	0.0167	0.0155	0.0148
Net operating revenue	.....	0.0149	0.0149	0.0154
Non-operating revenue	.....	0.0012	0.0011	0.0011
Gross income	.....	$0.0161	$0.0160	$0.0165
Deductions from gross income	.....	0.0011	0.0009	0.0008
Net income	.....	$0.0150	$0.0151	$0.0157

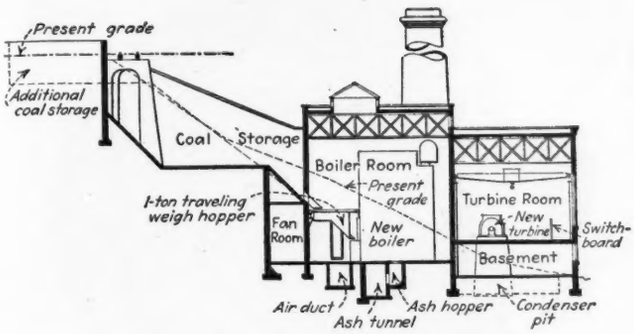
The rates under which these results have been accomplished are as follows: For lighting the rate is 7c. per kilowatt-hour for the first 200 kw-hr., with a graduation downward, according to consumption, to 4c. per kilowatt-hour for all energy over 400 kw.-hr. The rates are modified by a 10 per cent reduction for prompt payment.

Heating and cooking rates are 3½c. per kilowatt-hour



Maximum yearly peak loads from 1912 to 1928

[1]Made by H. C. Carroll, of the Commercial Testing and Engineering Company, of Chicago, who has served as consulting engineer for this plant over a period of seven years.



Elevation through plant showing gravity delivery of coal

for the first 100 kw.-hr. and 3c. per kilowatt-hour for all energy used beyond that amount, with ½c. per kilowatt-hour discount for prompt payment.

Sign rates are 4c. per kilowatt-hour, with a 10 per cent discount.

Power rates begin at 4c. per kilowatt-hour for the first 100 kw.-hr. and graduate downward, according to consumption, to 1½c., with the usual discount for prompt payment.

New Ammonia Control Valve Needs No Adjustment

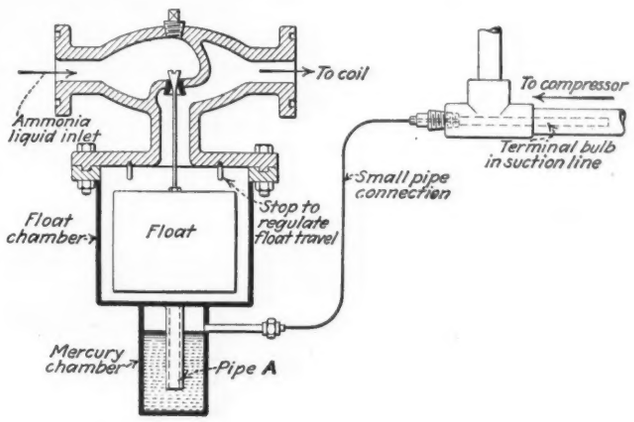
By Robert A. Wheaton

A NEW DESIGN of automatic ammonia expansion valve that has nothing to adjust and does not employ any diaphragm or springs in the construction is shown in the illustration. This valve works successfully for any capacity from 1 to 5 tons of refrigeration. Another interesting feature is the ability of the rig to automatically recharge the thermal bulb every time the plant shuts down.

As will be seen from the illustration, the valve is of the plug type and is inserted in the ammonia liquid line. Liquid ammonia fills a chamber in which is submerged a float connected to the plug valve. Liquid ammonia also fills the thermal bulb and connecting pipe line. A charge of mercury is placed in a lower chamber.

When the returning suction gases begin to carry superheat the ammonia gas and liquid in the thermal bulb is heated and thus generates a pressure in the bulb in excess of the pressure existing in the line to the expansion coil. This higher pressure builds up on the face of the mercury in the lower chamber and forces the mercury down in the chamber and up through a pipe into the float chamber. This lifts the float and opens the plug valve, which admits ammonia into the coil until the superheat disappears. When the ammonia in the thermal bulb is not superheated, the pressure in the float chamber is only the vapor pressure of the ammonia, and as this is less than that of the superheated gas the mercury returns to the lower chamber. The float then sinks down, closing the valve. The weight of the float pulling on the plug plus the pressure of the liquid from the high pressure side is sufficient to cause the valve to close and stay closed without leakage until superheating of the suction gas again opens it. The travel of the valve is only a fourth of an inch. In operation the action approximates a floating motion, free from shocks, thus insuring a long life. The valve plug and seat are removable, further increeasing the lift of the device.

After the rig is assembled, the air in the system is pumped out in the usual manner. When the low-pressure side is pumped out, the air in the thermal bulb will bubble out through the mercury. Ammonia is then charged into the high-pressure side, and when the cross connections on the compressor are opened, the high pressure will flood the low side, and the gas will find its way down pipe *A*



The ammonia is controlled by the suction temperature

and bubble up through the mercury to build up a pressure in the thermal bulb. The cross connections are then closed and the plant started up in the usual way. The valve will then begin to feed and keep on feeding as long as superheated gas flows over the thermal bulb.

Equipment Review

LAST year, for the first time, *Power* devoted an entire number to a review of power equipment that had been described during the preceding twelve months. The idea was so well received and responses from the field so favorable as to warrant making this a regular yearly feature. Therefore the

February 25 Number

will be devoted to a review of new equipment described in *Power* from January 1929 through January 1930.

It will be a number that one will want to keep and use constantly as a reference.

Unique Power Sources—A recent survey in Italy reveals 1,531 hp. of wind motors, industrially applied, and 11,350 kw. in one central station operated by terrestrial heat. The latter is capable of vastly greater development, according to a statistical publication on the production of electrical energy issued by the Italian Government. The huge column of steam and hot gases from Mount Etna, it is stated, ought to furnish energy for the whole of Sicily. Apparently, it is the intention to give serious attention to this source of power.

1,250-HP. MOTORS *Drive Boiler-Feed Pumps*

By P. C. SMITH
Motor Engineering Department
Westinghouse Electric & Manufacturing Co.

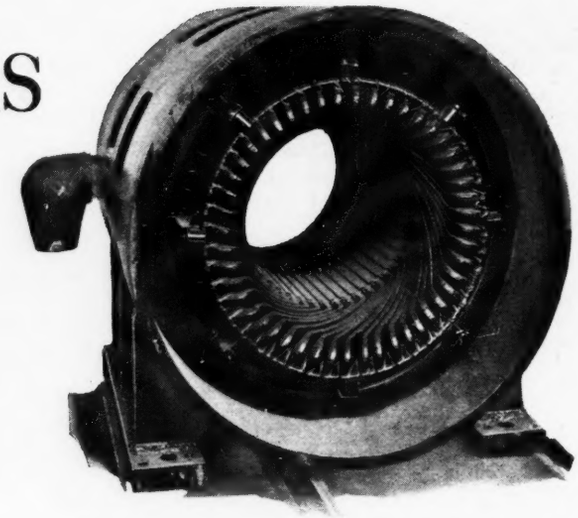


Fig. 3—Stator of 1,250-hp. 3,600-r.p.m. induction motor

ONE OF THE problems in a modern high-pressure steam plant is boiler-water supply. In Deepwater station the boiler-feed pumps are driven by 1,250-hp., 3,600-r.p.m. squirrel-cage induction motors. A total of 10,000 hp. is required to drive the pumps, which work against a boiler pressure of 1,400 lb. per square inch. To meet these high pressures new pumps were developed and a new motor to drive them.

On account of its high speed the motor has unusually small dimensions for its capacity. Using a fabricated frame helped to keep the dimensions small. The cylindrical part of the frame is a steel plate rolled into a ring, and the two ends are welded together. Heavy steel bars welded on the inside of this cylinder provide a seat for the stator core, which is separated from the frame proper to give free passage for the ventilating air. Holes for this air cut in the frame, and feet are welded on.

The stator core laminations are similar to those of the ordinary motor except they are thinner and are made of high-grade silicon steel. Open slots in the core allow easy placing and removing of the coils. The stator winding consists of wire-wound coils, insulated on the ends by treated cloth and on the slot sections by a mica wrapper held in place by cloth tape. Each coil is treated in an insulating compound before it is placed in the slot. After the stator is wound and connected, the winding is again treated and baked, producing a hard, smooth coating over the coils to protect them from moisture and other harmful elements in the atmosphere. The winding is wedged in the slots and the end turns are braced so that the motor may be started by connecting it directly across the line.

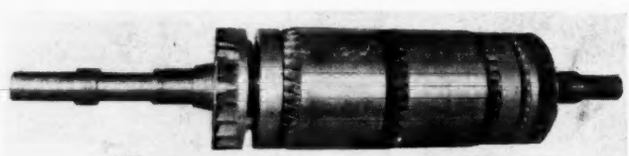


Fig. 1—Rotor-core laminations are pressed directly on the shaft

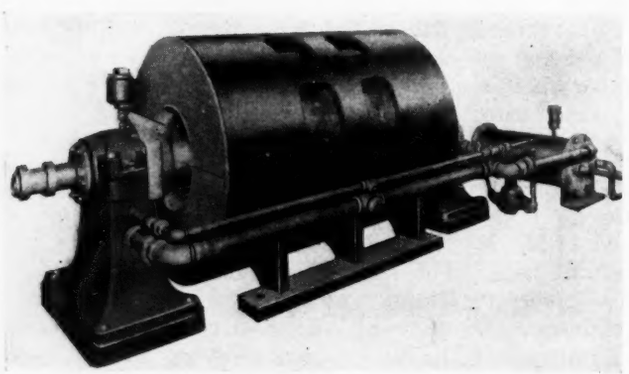


Fig. 2—Motor has a welded fabricated steel frame and forced lubrication

One-piece rotor punchings, of the same kind of steel as the stator, are mounted directly on a forged-steel shaft. The rotor core is tightly pressed between heavy end plates. Copper bars are forced into the partially closed slots and electrically brazed to the end rings. This mass of metal is balanced, and tests show it to run smoothly at 4,500 r.p.m. Blowers mounted on both ends of the rotor, Fig. 1, force cooling air through the end turns of the stator and rotor windings and then through axial ducts to a central radial duct, where it is discharged.

Pedestal-type bearings are used. They are lubricated by oil under pressure, the journal speed being too high for oil rings. A positive-feed pump, connected to the motor shaft by gears, forces the oil through the bearings. The oil is cooled in a small tank equipped with a water-cooling coil. From the bearings the oil flows to this tank by gravity and is recirculated by the pump. Glass sight gages on the side of the pedestals indicate how the system is functioning.

When starting a system of this kind it is necessary to provide separate lubrication until a few revolutions of the pump force oil to the bearings. This is accomplished by a starting reservoir mounted on top of the pedestal and connected to the bearing through a small pet-cock. For the initial start, the pump is primed and the starting reservoirs filled. Just before closing the starting switch the pet-cocks between the bearings and the oil reservoirs are opened, allowing oil to flow to the bearings by gravity. When the oil pump begins to put pressure on the bearings, oil flows back through the pet-cocks into the reservoirs. After the reservoirs are filled, the valves are closed, and the oiling system is ready for the next start.

Special precautions are taken to prevent oil leakage from the bearings and to keep out dust and dirt. The high air velocity resulting from the speed of the rotor produces a low-pressure zone at the air intake. On account of placing the bearings as close as possible to the rotor, the inner ends of the pedestals are in that zone. Since the outer ends are at atmospheric pressure, there is a tendency for air to flow through the bearings. Such an air flow, even though small, would take with it small particles of oil, some of which would be deposited on the winding and perhaps cause an insulation failure. Air flow is prevented by equalizing the pressure on the inner and outer ends of the pedestal. A casting over the inner end of the pedestal forms an air bypass connecting the inner end of the pedestal with air at practically the same pressure as that at the outer end. Oil throwers prevent oil from creeping along the shaft. Felt washers and a labyrinth seal are also used to protect the bearings.

While this type of motor was designed for boiler-feed pump drive, it is suitable for almost any direct-connected constant-speed application. At such a high speed, it is only natural that there should be some windage noise. The blowers and whole ventilating system are designed to reduce this to a minimum, so that the motors operate at the high speed of 3,600 r.p.m. with comparative quietness.

Page Mr. Edison

THE DREARY TASK of reading examinations is often enlivened by amusing bits of misinformation. So radical are the answers at times that the examiner feels himself on the verge of great discoveries. Power is indebted to the Ontario, Canada, Department of Labor for the following choice selections published in a recent bulletin:

Q.—Name some types of boilers.
A.—There are two kinds of boilers, some are Scotch boilers and some are common boilers.

Q.—How do you test the safety valves on a boiler?
A.—You blow the safety valves to expand the evaporation of the boiler.

Q.—What causes natural draught in a boiler?
A.—The natural draught is by opening windows and letting air come in.

Q.—If a fuse blew out of a motor, how would you know the size fuse to replace?
A.—If a fuse blew out and you did not know what size it was, you would have to take a pair of calipers and measure size.

Q.—Give meaning of terms: "Volt, Ampere, Watt."
A.—60 Amps.—1 Watt; 60 Watts—1 Volt.

Q.—What is meant by the term, boiler-horsepower?
A.—Means how much steam and how much water; in other words, how strong a boiler is.

Q.—How would you test the water pipe leading to the bottom of the water column?
A.—If there is no water in the boiler, we test it with a dry cock.

Q.—Where is the combustion chamber situated?
A.—Wherever the coal lies.

Q.—How would you test water pipe leading from boiler to bottom of water column?
A.—Put a pail in under the water column and blow down the glass

Q.—If your water glass broke, how could you still tell the water level?
A.—We see it by the steam gage.

Q.—What is the combustion chamber for?
A.—It's to clean the pipes.

Q.—What causes leaky tubes and how are they made tight?
A.—If leaking at ends of tubes, the babbit gets worn out, expanded too much. To remedy leaks I would solder up holes.

Q.—What are the tubes in a boiler for?
A.—To hold the steam inside the boiler.

Q.—How do you find the water level in boiler if gage glass is broken?
A.—Take a large piece of chalk and run down side of boiler, at the water level the chalk will turn brown.

Q.—How can you prevent scale from forming in a boiler?
A.—Blow out half the pressure in the boiler, then cool down the pressure and then blow the other half out.

Q.—What is superheated steam?
A.—Superheated steam is steam that has been hardened to lift a greater power.

Q.—Explain the advantages and disadvantages of the through stay, as compared with the diagonal stay.
A.—They are there to stand on, so the pipes won't bend.

Q.—If a fusible plug blew out, what would you do?
A.—If a fusible plug blew out, I would take out the water and the fire and get the man to fix the hole, or if the man cannot fix it I would get a new boiler.

Q.—What is latent heat?
A.—Latent heat is a term used as an iron after being heated and removed from the fire, or heat from boiler setting brickwork, or the cylinders of an engine when shut down after running.

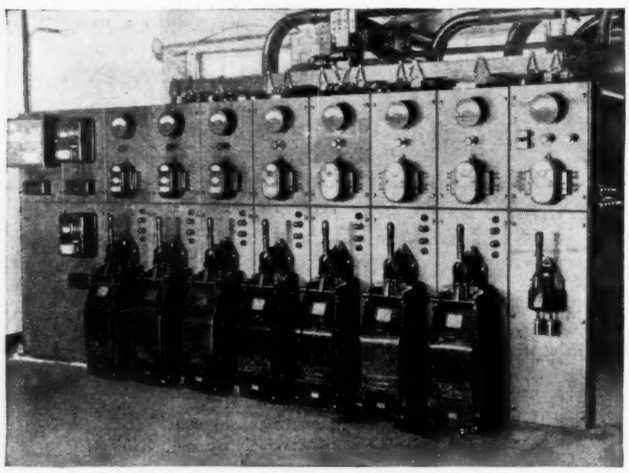
Q.—Tell what you know about a refrigeration plant.
A.—To cold some meat. The cold air from the compressor goes to the floor and pulls the warm air from the ceiling. Some have coils with air in them and some ammonia. Also a motor to drive compressor.

Departmental Demand Meters Help Reduce Peak Load

CURRENT for the Pratt & Whitney Company's plant, at Hartford, Conn., is supplied from three separate banks of transformers located in different sections of the plant so that the secondary distribution system might be as short and direct as possible. The transformers receive current from the local power company's high-tension-feeders, which are brought underground to each bank of transformers, and in each case an insurance feeder is also provided.

The various departments of the Pratt & Whitney Company, which are devoted exclusively to the manufacture of small tools and gages, are served by a bank of transformers that are now several years old.

When the installation was made the transformers were placed on a wooden platform that was inclosed by a wooden picket fence. The secondary feeders from these transformers were carried on glass insulators along the outside of the building wall. Numerous circuits



Distribution switchboard for the small tool works of the Pratt & Whitney Company

from the secondary feeders were taken through the building wall to fuse cut-outs and switches to which were connected power distribution and lighting panels. It can be seen that the entire secondary system was open wiring, and, in fact, many of the distributing panels and fuse cut-outs were of the open type.

The several advantages of the electrically heated furnace has led to its replacing the oil- and gas-fired heat-treating furnaces previously used. As the electric furnace requires considerable current, the electric load and maximum demand increased as the old furnaces were removed and replaced by electric equipment. At the same time a number of individual motor-driven machine tools were installed, which also increased maximum demand.

These two changes developed a condition of electric distribution and electric load that made necessary a new distribution system. To provide for the new conditions and entirely eliminate the old secondary distribution without delay to production it was decided that a new bank of two 450-kva. transformers should be installed. These were placed on steel rails laid in a concrete slab. A suitable curbing was provided around the outside of the slab, and the transformer bank was inclosed with standard 7-ft. wire on metal posts.

The high-tension feeders are brought under ground to a fireproof vault in which the necessary high-tension switches, meter equipment, busbars, etc., are installed, the operating handles and an incoming line meter of the maximum demand type being mounted on the outside of the vault. Low-tension current from the transformers, which is 220 volt, 2 phase, 60 cycle, is taken to the busbars of the power and lighting distribution switchboard shown in the picture.

Three combination graphic demand and watt-hour meters are mounted on the two panels nearest the high-tension vault. They measure the distribution of current to three separate divisions of the plant, and their totals should equal the reading of the maximum-demand and watt-hour meter that is on the high-tension feeders. One is the maximum-demand meter for the distribution board shown, so that the total reading of the kilowatt-hour meters on the panels should equal the reading in kilowatt-hours of this combination maximum-demand meter.

Graphic meters were installed so that the maximum demand could be watched, its cause determined, and conditions regulated to keep it at its lowest practicable point.

The electric furnace equipment is controlled by electric time clocks. The clocks make it possible to cut the furnaces in on the circuit at any time for which the clock is set. It was found that the foreman of the heat-treating department had set the clocks so as to bring the furnaces up to working temperature by 7 a.m. This resulted in the furnaces being still on the line and taking current when workmen in the manufacturing divisions were starting the motors for operating machinery. The electric furnace load plus the starting load of production machinery resulted in a peak demand for power. This condition was shown by the demand-meter chart.

Setting the time clocks controlling the furnaces from 20 to 30 min. earlier brought the electric furnaces up to working temperature before electric motor load came on. It can thus be seen that the use of the graphic meter made it possible to operate the electric furnaces in such a way as to reduce the maximum demand. The rate structure makes it important that the peak load be kept as low as possible.

The remaining eight panels of the switchboard distribute power to various parts of the small tool works. On each is mounted a remotely controlled oil circuit breaker, watt-hour meter and ammeter. The meter on the right-hand panel measures the energy used for building lighting, the main distributing panel being located on the first floor.

From the next two boards two 1,000-amp. circuits carry power to a switchboard on the top floor of the building, from which it is distributed to the heat-treatment furnaces. Power required for the motor drives is supplied through the next four panels. The remaining panel is a spare. Remote controls for the oil circuit breakers are located at the distribution switchboard of each floor, so that in case of trouble all of the motors on the floor can quickly be stopped.

The information for this article was secured through the courtesy of H. W. Benton, plant engineer, Pratt & Whitney Company.

Right Out of the Plant

Solenoid Transfer System for Remote Indication and Record

ABOUT a year ago it became necessary to transfer the indicated meter readings of boiler-feed water from the pump room of a power plant up to the switchboard operating room, two floors above the meter body and the differential tube, a distance of some 350 feet.

It was found that it could be done satisfactorily with a pair of Selsyn motors. Five leads had to be run from the meter body up to the operating room, with the necessary chain drive from the meter shaft to one motor and then to a flat-dialed indicator on the switchboard. One disadvantage of this arrangement was that the switchboard indicator could not be furnished to match the many meters of the curved-dial type on the board. Also, the cost would almost equal the purchase price of an electrically operated flow meter. But, to install the latter, several changes in the 8-in. boiler-feed line, etc., would have to be made. It was decided to make a remote indicator of parts on hand in the power station. After two months of occasional experimenting and testing, two methods were decided upon: one using a voltmeter and one using an ammeter with specially calibrated dials for the secondary, or remote, indicator. The second method was found to be more reliable, cheaper, and easier to install, for the following reasons: There was only one coil or winding required in the meter body casing, and only two wires or leads to be run from the meter casing to the switchboard, while on the first method there would have to be two coils or windings in the meter body and four wires from the meter casing to the switchboard or two to the switchboard and two to some source of alternating-current.

Referring to Fig. 1, a solenoid *A* with a laminated movable armature is located in the meter casing. A flat grooved sheave *B* or a flat grooved eccentric or cam is placed on the main shaft of the meter between the main cam and meter casing. The diameter of this sheave or eccentric is such as to give proper travel of the armature in the solenoid when the meter travels from zero to full scale reading. A sheave is used when the scale on the remote indicator is required to read exactly with the indicator hand on the meter, but when the remote indicator is required to read exactly with the recording pen an eccentric or cam is used.

The laminated armature is raised and lowered in the solenoid by a flexible braided wire passed around the sheave, the opposite side of which is balanced by a suitable counterweight *C* equal to the weight of the armature and magnetic pull of the solenoid, thereby removing practically all friction from the meter operation.

The solenoid winding is connected in series with the primary side of an instrument transformer, as shown in Fig. 2. The secondary of this transformer is connected to an alternating-current ammeter, the current required for full-scale reading corresponding to the maximum current obtainable in the transformer secondary at the impressed voltage. The ammeter used was of the curved-dial type to match the meters already on the switchboard.

From the foregoing it will clearly be seen that as the armature is raised out of the solenoid the voltage in the transformer primary winding will be increased and the voltage induced in the secondary will be increased in a proportion equal to the transformer ratio, which in turn increases the current in the alternating-current ammeter, which is graduated to correspond with the water meter being used. When the armature is lowered into the solenoid, the reverse occurs, and the current in the ammeter decreases.

A remote indicator electrically operated as described in the foregoing has been in operation daily for over a year and has given no trouble whatsoever. It has been checked several times to prove its accuracy, and has been the object of favorable comment by several meter men.

At about the same time it also became necessary to transfer the indicated boiler pressure from the boiler room. This was done in a similar manner. The diaphragm and main lever of a discarded damper regulator, as shown in Fig. 3, were used.

The limiting screws for the lever travel were adjusted for a maximum movement corresponding to 20 lb. change in pressure. At the end of the main lever the movable armature was attached, as shown, the movement of armature being such as to give maximum readings on the indicator in the switchboard room, which is graduated for the proper pressure.

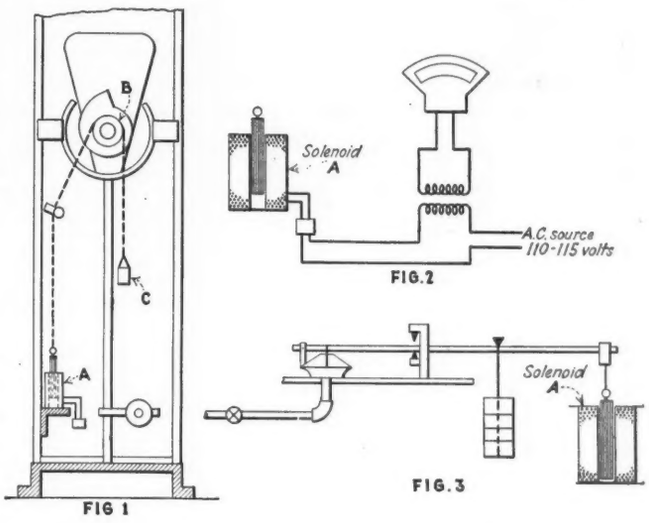


FIG 1 FIG.2 FIG.3

Typical arrangement of solenoid transfer systems

There is almost no limit to the application of the foregoing system, as any style or size of meter or secondary indicator can be used. The size of secondary dial is also unlimited. By using an inexpensive ammeter of the solenoid type, a dial of any diameter with a properly balanced indicating hand of any length can be employed.

This system can be used to indicate tank or pond levels, positions of valves, dampers, etc.

Somerset, Mass. WILLIAM H. BURTON.

Improved Operation Obtained Through Use of Home-Made Draft Gage

THE IMPORTANT part a U-tube gage can play in the operation of a bank of boilers was demonstrated to us some time ago after much experimenting and expense. The plant consisted of four horizontal-return-tubular boilers connected by a common flue to a single brick chimney. For several months the firemen complained of poor results from boiler Nos. 1 and 2. (They were furthest from the chimney.) The other two boilers seemed to fire more easily, and consequently the firemen centered their efforts on these to keep up steam, Nos. 1 and 2 boilers being allowed to drift along.

The plant had several modern attachments for observing the operation of the engines and boilers, but draft gages had not been installed. After several experiments with dampers and fuel bed thicknesses, which got us nowhere, we rigged up a U-tube from gage glasses and rubber hose. With this simple device we located the trouble at once. Draft readings in inches were 0.2, 0.3, 0.7, 01.1, for boilers 1, 2, 3, and 4, respectively. With the assistance of our U-tube we regulated the individual dampers on each boiler to give approximately 0.7-in. draft on each boiler.

As a result four differential draft gages were bought and installed. This made things easier for the firemen and resulted in a considerable saving in fuel, as we were able to drop one boiler off the line.

Rosedale, L. I. JOSEPH O'BRIEN.

Sodium Aluminate Not a Colloid

IN THE Jan. 14, number of *Power* George C. Reinhard writes, "Two materials that commonly go into the category of soda compounds, sodium silicate and sodium aluminate, are, strictly speaking, colloids. They are not chemical compounds possessing the formula given to them." He also says, "Considering sodium aluminate, which likewise has been misnamed, being more strictly a colloidal solution of aluminum hydroxide that has been peptized or brought into colloidal solution by caustic soda, we obtain a similar succession of events, but instead of silica as the final product, we obtain oxide of alumina."

It has been the policy of the National Aluminate Corporation to recommend chemicals for boiler water conditioning under their accepted trade names, so that customers could purchase their needs most advantageously. This policy has also been accompanied with methods for testing feed and boiler water. Intelligent control of boiler water conditions can be secured only in this manner. The apparent mystery of water treatment has been dispelled in a technical manner, and the art of water conditioning has been shown to be a series of chemical reactions, proceeding in a definite manner, and to a definite end, under conditions which can be controlled by standard inorganic chemicals.

Sodium aluminate is sold as a coagulent. It is considered a true compound, the soda being present as a distinct part of this compound and not as a peptizing agent. Where additional "soda compounds" are required for proper water conditioning, they are introduced as such, using caustic soda, soda ash, etc.

The statement that sodium aluminate is a colloid warrants consideration. In the past we were inclined to attribute some of the actions of sodium aluminate to the possible existence of "a colloidal solution of aluminum hydroxide . . . peptized . . . by caustic soda." More recently we have made a very thorough study of colloids in connection with water treatment. Part of this has been published (*Journal of the American Water Works Association,* vol. 12, pp. 1076-80, 1929). This investigation, which has included ultramicroscopic studies, electrophoresis measurements, dialysis, and coagulation tests with known colloids of both charges, indicates definitely that the sodium aluminate manufactured by the National Aluminate Corporation contains less colloidal matter than does water taken from Lake Michigan. Certainly there is no justification for stating or even assuming that the commercial sodium aluminate can attribute any of its results to the possible existence of a colloidal state. Thus we find that one of the premises upon which Mr. Reinhard has based his comparisons is not tenable and has no basis.

The use of sodium aluminate for coagulation of suspended solids in boiler water is, therefore, not dependent on colloidal action but rather on direct chemical reaction with the encrusting solids naturally present in the water. Thus it is not necessary to peptize the so-called colloids before treatment or to depend upon coagulation other than through direct chemical reactions.

To compare sodium aluminate with sodium silicate is not justifiable. Silica in any form, whether soluble, colloidal, or suspended, can be considered dangerous as a scale-forming substance. To counteract silica scale formation, sodium aluminate is used because of its direct chemical reaction on soluble silica. Thus a material which increases the silica content of boiler water has been compared with one used largely to counteract this same silica.

The accompanying tables indicate the reactions of sodium aluminate. They show the amount of suspended and dissolved solids, actual sodium hydrate and carbonate, hydrogen-ion concentration, silica and alumina in solution (filtered), silica and alumina in suspension and total suspended and dissolved silica and alumina in the feed water; also the degree of coagulation by physical appearance.

ANALYSIS OF BOILER WATERS

(Grains per gallon)

Location	Susp. Solids	Diss. Solids	Sod. Hydrate	Sod. Carb.	pH	Sol. Silica	Sol. Alumina	*R. W. Silica	Coagulation
Without Sodium Aluminate									
Chicago, Ill.	28.0	13.4	0	0	....	1.1	0.40	....	Poor
Lorain, Ohio	186.4	32.3	0.8	0	....	6.35	0.10	14.45	Poor
Butte, Mont.	29.7	119.4	16.3	16.2	....	5.09	0.41	0.48	Poor
Syracuse, N. Y.	45.6	33.6	0.0	8.6	....	1.15	0.31	....	Poor
Pueblo, Colo.	50.6	130.4	0.0	0.0	10.1	0.26	0.29	0.46	Fair
Tacoma, Wash.	124.2	446.3	24.6	21.2	11.2	7.41	0.31	2.6	Good
Toledo, Ohio	9.4	18.8	0.0	4.8	9.1	3.23	0.70	....	Poor
Philadelphia, Pa.	72.1	154.2	7.7	27.8	....	9.2	0.70	....	Poor
Deferiet, N. Y.	15.6	81.0	0	0	9.3	2.1	0.16	....	Poor
Chadron Neb.	306.2	113.4	33.3	16.1	11.9	4.61	0.39	3.01	Poor
Average	....	....	....	....	....	4.05	0.38	4.2	....
With Sodium Aluminate									
Clinton, Iowa	113.3	50.5	8.2	11.0	11.4	0.21	2.09	....	Good
Atlantic, Iowa	94.9	232.9	0.0	5.3	9.7	0.88	1.43	....	Good
Everett, Wash.	0.8	29.0	2.9	7.0	11.0	0.71	1.37	1.0	Fair
Detroit, Mich.	20.9	78.7	0.3	10.2	11.0	0.32	0.24	....	Good
Rainier, Wash.	21.1	62.3	4.2	13.0	11.3	1.24	1.15	0.75	Fair
Syracuse, N. Y.	25.4	55.2	8.3	7.3	11.4	0.77	0.40	....	Good
Sandusky, Ohio	161.1	129.6	4.6	5.2	....	2.50	0.10	....	Fair
Chicago, Ill.	11.8	87.9	20.8	17.0	11.6	1.17	1.38	3.39	Good
Milwaukee, Wis.	386.5	117.1	11.3	39.0	....	0.64	0.61	....	Good
Lorain, Ohio	199.7	32.3	0.7	4.5	....	1.05	1.03	4.45	Good
Butte, Mont.	26.9	38.0	3.5	10.1	....	1.78	2.66	0.48	Good
Saginaw, Mich.	361.8	178.7	0	0	10.7	0.97	2.76	....	Good
Average	....	....	....	....	....	1.02	1.27	4.01	Good

*Total silica—both dissolved and in suspension.

The tables indicate clearly the effect of sodium aluminate on silica, proving, whether the reaction is colloidal or not, that silica reduction is obtained and that this reaction proceeds under conditions encountered in plant practice. These tables further indicate that sodium

aluminate does not depend on colloidal reactions, as shown by the soluble alumina content of the boiler waters. If the aluminate reverted to the oxide, this oxide would be soluble at the alkalinities and pH values shown. However, such is not the case, as the soluble alumina in the sodium-aluminate-treated boiler water is little higher than in the untreated boiler waters even though relatively large amounts of alumina are added in the treatment. Comparison of alumina content in the boiler sludge to that in solution demonstrates this point.

From the above it would appear that Mr. Reinhard's conclusions on sodium silicate may be true. However, the assumption that sodium aluminate reverts to oxides which are of no value is shown to be not true and that for internal treatment of boiler water the placing of sodium aluminate in the class of colloids is contrary to established facts.

J. A. HOLMES,
Director of Service,
National Aluminate Corporation.

Chicago, Ill.

Research Has Done Much for Welding

I WAS much interested in the item "A Welding Thought Flys Home With Chickens" in the Dec. 31 number of *Power,* because I am well aware that the technique of fusion welding has passed far beyond the experimental stage and that through the research of specializing metallurgists has become a most reliable method of performing certain operations in the repair and reconditioning of power-plant machinery. There is little doubt that during recent years more progress has been made in connection with welding both by the electrical and gaseous methods than in any process allied to, or forming a part of, engineering practice.

It is well known that autogenous or fusion welding has been of incalculable value on repair work, for broken parts may not only be repaired at considerably less than the cost of new parts, but the speed with which the repairs may be effected is undoubtedly a big advantage.

To perform fusion welding successfully, correct technique and efficient manipulation of the welding torch are of first importance. The equipment should be modern. Unfortunately, many power plant engineers have the idea that the personal equation is the difficult problem in autogenous welding practice. True, good welding operators are necessary, but they must also have good materials to weld with. Experience has shown that one of the most important of materials is the welding rod, and the research laboratories in the welding industry are devoting much attention to developing new and improved rods for both ferrous and non-ferrous materials.

An important factor that must be anticipated in the development of new welding rods is the change in chemical composition which takes place when they are melted by the torch flame. They must be of such composition that the metal in the weld joint will be sound and of high quality. An important development in welding rods is the high-strength bronze welding rod brought out during 1929. It overcomes loss of zinc by certain changes in the chemical composition. The metal acts as an entirely different alloy than the customary types of welding rod. Zinc fumes are almost eliminated. The new rod melts as a uniform alloy, has a melting point which is not altered by remelting and when molten always has a clear creamy appearance. Solidification of the puddle is rapid, and the weld metal is free from gas pockets and porosity.

A. EYLES.

Manchester, England.

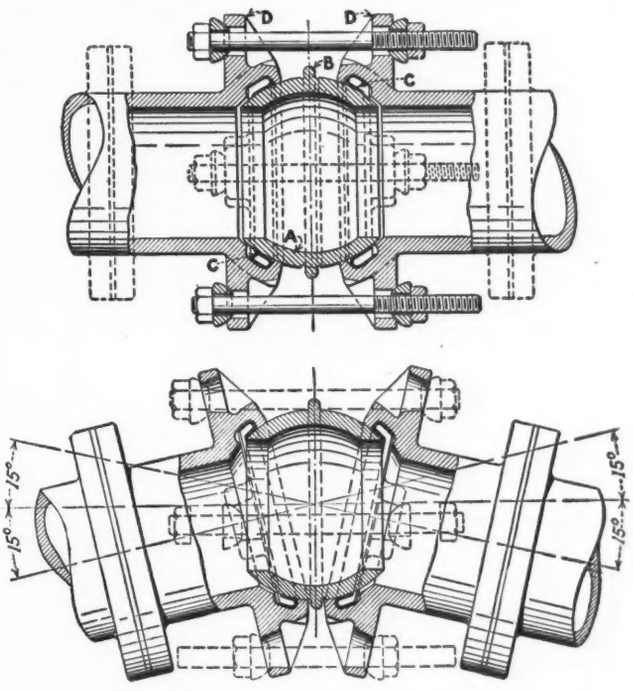
Hydraulic Ball-Connected "Flex" System for Pressure Mains

THE ESSENTIAL purpose of the hydraulic ball-connected "flex" system for pressure mains shown in the accompanying illustration is to provide a comparatively inexpensive means whereby a pressure main carrying steam, water, oil or air may easily be diverted from a straight, or from a right-angled, course without special bends. Not infrequently conditions arise where it is imperative that the line be diverted several degrees to clear obstructions unforeseen in the design of the layout and which it is inconvenient if not impossible to remove

Not only is the new ball-connection designed to adequately meet such need, but it is so constructed that the higher the pressure the tighter the joint.

In the illustration a joint is shown straight and flexed to approximately its fullest extent, 15 deg. each side of a center line, or 30 deg. in all.

Referring to the illustration, *A* is a hollow cast-iron ball with the ends open and provided with a stop collar *B* to prevent the joint being flexed beyond the permissible limit. *C* and *C* are the hydraulic (Bramah) rings. To give increased durability these rings might be spun from



Joint straight and flexed to maximum

phosphor bronze sheet. The cast members *D* may have either flanged or spigot ends. Adequate provision is made in the bolting arrangement for the flexing necessary, and special hemispherical seats and washers with enlarged holes are provided.

It is presumed that in the design or layout of any pipe line the usual straight lengths as well as the 90-deg. bends are provided; and it will be readily seen that with the adoption of flex members (standardized) no special bends are necessary.

An important feature of this joint, and a most useful one, is the fact that a circular "ring" main may be made with straight lengths and flex members in place of special bends.

J. T. TOWLSON.

London, England.

FROM AMONG READERS' PROBLEMS

Conducted by L. H. MORRISON

PROPER BOILER PRESSURE WITH TURBINE—*We desire to install a 2,500-kw. bleeder turbine, and figure that the turbine throttle pressure should be 400 lb. gage. What is the desirable working pressure for the boilers and for what pressure should they be designed?* C.C.C.

With the maximum load on the boiler and turbine, the line pressure drop should be around 15 lb. The drop through the superheater should range from 9 lb. at normal output to 20 lb. at maximum output; the average load drop should be figured at 12 lb. This makes the total drop between boiler working pressure and turbine throttle pressure 27 lb., which calls for a boiler working pressure of 427 lb. gage, and to care for overload rating it should be taken as 435 lb. If the lowest safety valve be set to have a 4 per cent blowdown, the valve-closing pressure should be about 440 lb., making the pressure 455 lb., for which the boiler should be designed.

BOILER EFFICIENCY—*We ran a boiler test, obtaining the following data: Steam pressure, 100 lb. gage; moisture, 4 per cent; feed-water temperature, 132 deg. F.; water evaporated, 40,000 lb.; coal used, 4,000 lb.; heat value of coal, 13,990 B.t.u. per pound.*

How is the efficiency found? B.M.

The total heat in a pound of dry saturated steam can be separated into two parts, the heat of the liquid and the latent heat of evaporation.

At 100-lb. gage, 115-lb. abs., each pound of water at the corresponding temperature of 338 deg. F. contains 309 B.t.u., measured from water at 32 deg. F. If the pound were evaporated into dry steam there would be added 879.8 B.t.u. more, but as there was 4 per cent moisture in the steam, obviously only 96 per cent of each pound was evaporated, or each pound had added to it $\frac{96}{100} \times 879.8 = 844.6$ B.t.u. The total heat in each pound of the mixture is then $309 + 844.6 = 1{,}153.6$ B.t.u. But the feed water at 132 deg. F. had in it 99.88 B.t.u. per pound, as measured from 32 deg. F. The net heat absorbed from the furnace per pound of water was then $1{,}153.6 - 99.88 = 1{,}053.7$ B.t.u., and 40,000 lb. would absorb 42,148,000 B.t.u.

The coal contained, $4{,}000 \times 13{,}990 = 55{,}960{,}000$ B.t.u., so the boiler efficiency was $\frac{42{,}148{,}000}{55{,}960{,}000} = 75.3$ per cent.

EFFECT OF STATIC CONDENSER ON POWER FACTOR—*When a static condenser is connected to the terminals of an induction motor is the power factor of the motor corrected?* O.M.

The power factor of the motor is not corrected, but the power factor of the system is, between the static condenser and the generators in the power plant. In an induction motor of a given design, the load has the greatest influence on the motor's power factor. Variations in voltage and frequency also have an effect, but within reasonable limits these effects are small compared to the changes in power factor due to changes in load. The power factor of a slow-speed motor falls off faster as its load is decreased than does the power factor of a high-speed motor. The power factor of a high-speed induction motor may be 0.90 at full load and 0.80 at half load. A slow-speed motor's power factors for corresponding loads may be 0.75 and 0.55, respectively.

The current supplied to an induction motor may be divided into two components, namely a power component that is in step with the voltage, and a magnetizing component 90 deg. out of step with the voltage. This magnetizing component of the current does not represent any useful power. At one instant the magnetizing current transmits energy from the generator to the motor. This current magnetizes the motor, and the energy transmitted by it is stored in the magnetic field. When the magnetic field is decreasing in value its stored energy is being transmitted back to the generator. If a static condenser of the proper size is connected near the motor, the magnetizing current will alternate back and forth between the motor and the condenser. Under this condition all of the equipment back of the condenser is relieved of the motor's magnetizing current and the power factor of the supply apparatus is improved.

PREVIOUS QUESTION

DISCUSSED BY READERS

THE QUESTION

ON A newly erected 550-lb. B. & W. type water-tube boiler bad leakage occurred, not only at the handhole gaskets, but also at the expanded tube joints, although the boiler was carefully tested with cold water pressure before starting up and found to be tight in every respect.

By mistake the alkalinity of the boiler water was kept as high as 150 grains of caustic per gallon at the start, and now the question is whether such a high alkalinity may have been the cause of the leakage in expanded tube joints. W.F.

IN ORDER to analyze the problem of the leakage of tubes and handhole gasket of the 550-lb. boiler, certain facts must be considered and certain assumptions must be made.

A boiler tested with cold water may not be tight when placed in service. The test water should have a temperature of not less than 70 deg. F.; 212 deg. F. is better.

Expansion of the parts due to increase in temperature may disturb the seal made by a calked seam or by a rolled tube. A solution of caustic at low temperature does not corrode, but at elevated temperatures corrosion is likely to take place, and over a considerable period of time it may pierce a tube or the calking seal at a seam to the extent that leakage will appear.

This action will affect a clean boiler with greater rapidity than it will a boiler in which there is a complete coating of scale. However, in the sodium-carbonate water district it is not unusual for boilers to be operated with an alkalinity of 1,500 to 1,800 grains per gallon without developing leakage.

If the tube end is not perfectly cleaned, that is, polished with emery cloth, the coating of mill scab, rust, or oil may be sufficient to cause slippage and leakage as the result of expansion stresses.

The action of high-caustic solution upon rust and oil is well known. In view of the leakage at the handhole gasket, it appears that the caustic acted upon the oil with which the walls of the tube holes, the tube ends and handhole bearing had been treated and so was the indirect cause of the leakage.

Another frequent cause of leakage at seams and tube ends of new boilers is the short time taken to "put the boiler on the line" after the preliminary drying out has been completed. The change in the furnace from the normal temperature of 70 deg. F. to 3,000 deg. F. within a half hour must produce stresses likely to result in leakage.

Boston, Mass. M. P. JONES.

IT IS my opinion that feed water carrying as high as 150 grains of caustic per gallon will cause leaks, even in a new boiler, if the excess of alkalinity is allowed to run for any length of time. Leaks will be noticed around the handhole gaskets, if at no other place. It seems that it is almost impossible to keep all gaskets tight where water feed is kept caustic enough to prevent scale in water that carries a high content of scale-forming solids.

As for the leaks around the tube ends, that is another question. If the tube ends were rolled good and tight it is my opinion that while there may be some seepage, there is not any great amount of leakage, and when the alkalinity is brought down to normal these leaks will disappear.

I have seen water-tube boilers tested with cold water at 65 per cent above working pressure, yet after several days' operation leaks appeared. No alkaline compounds had been introduced into these boilers.

In boilers that carry as high a pressure as the one in question, namely, 550 lb., it is essential that the tube ends be rolled good and tight. But even when this is done there may be some leaks after the boiler is put in service. It is my opinion that the excessive alkalinity of the boiler water in this case is a contributing cause. Also that there are other reasons for the leakage at the tube joints.

JOHN W. STEPHENS,
Chief Engineer,
Staunton, Va. White Star Mills.

THE SUBJECT brings us into a field where most of the information and knowledge has been gained by research work rather than by practical experience.

The actual cause of the leaks cannot be definitely settled except by elimination of other possible causes, for which information is not available in the description of the conditions surrounding the case.

First, the leaks at the tubes and gaskets may be caused by expansions and contractions due to too rapid raising of steam. Secondly, the question arises, how long had the condition of the excessive alkalinity been prevailing before the leakage took place? What was the relationship between the sulphates and the caustic alkalinity during the period involved?

Nevertheless, the question can be answered hypothetically and on the assumption that the raising of steam was done carefully and with all due consideration to stresses caused by uneven expansion and contraction. Likewise it must be assumed that the excessive caustic-alkalinity condition has been prevailing for a considerable time.

As stated, the actual practical and recorded experience under conditions such as these are very limited, and for that reason references have to be made to such works where, under laboratory conditions, theories have been evolved that govern the case under consideration.

Eliminating all other causes, the conditions that arose in the boiler under discussion can only be indexed under caustic embrittlement.

Let us disregard, at present, the handhole gaskets, the leakage of which can only have been caused by the identical reason that made the tubes leak. Leaky tubes can be due to one condition only, the seats between the tubes and the headers were destroyed.

The destruction of the seat between an expanded tube and a sheet or header is, under ordinary conditions, caused by corrosion. In a Scotch boiler where scale has been allowed to accumulate around the neck of the tubes for any considerable period of time the magnesium sulphate usually contained in the scale, under reaction with sodium chloride, will develop magnesium chloride, which again will penetrate and corrode the intimate contact between the expanded tube and the seat in the sheet.

In a water-tube boiler, this condition is not common, due to the construction of the boiler itself. Scale accumulations around the neck on the water side of the tube can take place only in the header, where the conditions for penetration of magnesium chlorides into the seat are not favorable.

With high alkalinity in a water-tube boiler certain other conditions arise, of which no better description can be given than by quoting Dr. Speller, in a condensed and transposed manner, as follows:

"Without going into details about the hydrogen-ion concentration, which subject is a science in itself, hydrogen, ammonia, and other reducing gases have the power of penetrating iron, nickel, copper and some of the alloys at elevated temperatures and reducing the oxides at the grain boundaries. This action may result in intercrystalline cracks. The action of hydrogen in causing embrittlement of steel in contact with acid or hot caustic solution and of ammonia gas on metals at high temperatures are outstanding examples."

Another contributory cause to the condition referred to may be found in unsuitable "pickling" of the metal in the tubes before manufacture of the boiler.

Further concerning hydrogen embrittlement, another condition which may apply to this case, Dr. Speller writes: "The steel in such cases has been found to become brittle and also carries considerable occluded hydrogen, hence this condition of metal has been termed hydrogen embrittlement. Such cracks have been found in leaky seams under a few special condition, including boilers in elevated geographical districts where the feed waters are high in sodium carbonate and low in sulphates, as well as other cases where considerable amounts of sodium carbonate were added to boilers operating on distilled water.

The sodium carbonate in this last case, and particularly under pressures such as referred to in the question, will break up into caustic soda and carbon dioxide. It is probable that the caustic soda may become concentrated sufficiently in sharp angles, riveted seams or small incipient cracks.

Eliminating all other reasons and considering only the excessive caustic alkalinity carried as a cause for the condition, the leakages are undoubtedly due to cracks developed in the tubes and in the seats of the handholes as a consequence of excessive caustic alkalinity without sufficient counteracting sulphates.

In boilers of the pressure referred to the sulphates should be at least three times the amount of carbonate alkalinity of the boiler water.

It is highly probable that the conditions such as described are entirely due to excessive caustic alkalinity maintained for a period which has not been stated in the question; in fact by the process of elimination, the assumption becomes a certainty.

J. H. GULLAK,
Mechanical Engineer,
J. H. Gullak & Co., Inc.
New York City.

I had an experience similar to the one under discussion, and I found the trouble was due to oil having been used on the tube sheets during assembly of the boiler.

The oil rolled in between the tube and tube sheets remains there, and when the cold water test is made the oil film holds the pressure. But as soon as the boiler is fired the equal expansion of the steel and oil permits the alkalinity to pass into the joint and this causes the leak.

STEPHEN KULICH.
New York City.

A Question for Our Readers

WE are building a 1,000-kw. 350-lb. plant and plan to weld the low-pressure piping. Is it advisable to also weld the high-pressure piping, and how can we know that the contractor is doing a good welding job? C.M.V.

Suitable answers from readers will be paid for and published in the March 11 issue.

Heating Buildings Electrically by Thermal Storage

By S. E. MONKHOUSE AND L. C. GRANT

TO MAKE electric heating of buildings an economic possibility it is necessary that the energy be purchased at much-reduced rates. For a constant load taken regularly each day, but confined to off-peak hours only, an appreciable reduction in prices charged may generally be obtained. By making use of thermal storage, advantage may be taken of the lowered cost of off-peak electricity for the heating of buildings.

An economical method now employed for storing heat from off-peak energy is to heat water during the off-peak hours and to store it in tanks for use when required during the remainder of the 24 hours.

The specific heat of water is 1, and its specific gravity is also 1. It can generally be loaded under pressure to store heat at 280 deg., thus giving a working range of 280—120, equal to 160 deg., which enables 160 B.t.u. to be stored per pound, or $160 \times 62.5 =$ 10,000 B.t.u. per cubic foot. The cost of water per 10,000 B.t.u. stored is about 0.1 pence (0.2 cents) with water at 1 shilling, 4 pence (32 cents) per 1,000 gallons.

Electric energy may be converted into heat by electric water heaters, which are not, strictly speaking, boilers, or by electric steam boilers in which steam is produced and is subsequently utilized as a medium for transferring the steam to the storage system proper.

The heating may be accomplished either by current supplied to electrodes immersed in the water, or by resistance heaters, wherein the current is used to heat wire, wound around resistors, which in turn heat the water.

Combined storage and heater systems usually consist of one or more drums, that are fitted with immersion heaters. The circulating system is connected to the top of the drum. Hot water is drawn off and added to the water in the circulating system, while an equal amount of cold water is returned from the circulating system to the cylinder. The relative proportion of water recirculated and that drawn from the storage cylinder is regulated by automatic valves.

The separate unit system makes use of a heater separate from the storage system, and is used when a steam-raising boiler has advantages over a water heater on account of its greater flexibility in operation. Such a boiler necessitates the use of heat-transfer equipment between the boiler and the storage system. The heat exchangers generally are similar to closed-type feed-water heaters. Steam from the boilers is passed into the outer space between tubes, while through the latter the water from the storage cylinder is pumped and so warmed by contact with the steam-heated tubes.

The largest installation of this nature is said to be at Carloil House, England. Separate electric boilers and storage cylinders are used with intermediate heat transfer equipment. There are two three-phase boilers capable of dissipating approximately 1,200 kilowatts.

The boilers deliver steam at 55-lb. pressure, the steam production being controlled by an electric-regulating-valve system, which balances the water input against the electrical input. In addition there is a pressure-retaining valve that maintains a fixed steam pressure on the boilers and opens to pass steam only when the pressure exceeds this.

The heat exchangers, of which there are two, arranged so that either or both can be used in conjunction with each of the boilers, are each capable of handling an average steam output equivalent to 650 kw. dissipation.

The two storage drums each measure 34 ft. in length and 9 ft. 6 in. in diameter, and inclose a total volume of approximately 4,800 cu. ft., or 30,000 gal., under a pressure of 48 lb. Thus the water stored is at a temperature of 280 degrees and contains approximately 60,000,000 B.t.u., of which about 50,000,000 are available for heating.

During the past few years there have been developments both here and abroad in equipment for heating buildings with electricity. This article, abstracted from a paper presented before the Institution of Electrical Engineers, indicates how off-peak power may be used for this purpose and gives operating data for an installation in a large building in the north of England.

Radiators installed in the building are of the panel type, each panel consisting of a grid of ½ in. internal diameter tubing sunk into the concrete ceiling and covered with a thin layer of plaster. The normal dissipation of each panel is about 8,000 B.t.u. per hour.

The building as so far erected is incomplete, but that portion in use has been occupied for two heating seasons and has an approximate content of 1,750,000 cu. ft. During the last complete heating period the building required an average daily input of 5,300 kw. The average outside temperature during this period was 44.3 deg., and the air in the building was maintained at a temperature of 63 deg. The consumption of current in all cases was confined to a period between 7 p.m. and 7 a.m., and was purchased at the rate of 0.3 pence (0.6 cents) per kilowatt.

COMPARISON BETWEEN COKE AND ELECTRIC HEATING AT CARLIOL HOUSE*

	Coke	Electricity
Capital Charges		
Cost of whole scheme, including domestic hot-water apparatus.	$17,500	$27,200
Estimated Annual Charges (Normal Winter)		
Energy—1,100,000 kw.-hr. at 0.6 cents	.....	6,600
Fuel—500 tons coke at $6.24	3,120	.....
Interest on plant at 6 per cent.	1,050	1,630
Depreciation fund on boiler-house plant:		
Coke—10 years at 7.95 per cent	1,390	.....
Electric—20 years at 3.02 per cent	.....	820
Maintenance and renewals	730	146
Attendance	2,670	.....
Ash removal	146	.....
Total	$9,106	$9,196

The table shows a comparison between the cost of heating this building electrically and with coke. Under the assumed operating conditions the two systems compare closely, with a slight advantage in cost to the coke installation. This difference, it is felt, is made up by the lack of dust, the absence of smoke nuisance, and its greater convenience.

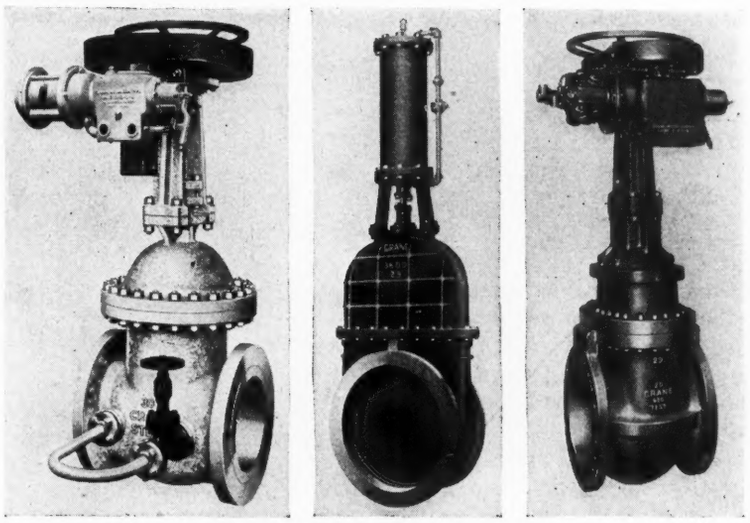
[*Apparently the authors have assumed the efficiency of the coke plant to be only 31.4 per cent of the efficiency of electric heating, since

$$\frac{1{,}100{,}000 \times 3415}{.314 \times 12{,}000 \times 2000} = 500 \text{ tons,}$$

where the heating value of the coke is taken at 12,000 B.t.u. per pound. This is greatly below American heating practice, where efficiencies of 65 per cent are common. With an efficiency of 65 per cent only 240 tons of coke would be required, costing $1,500 instead of $3,120 making the cost of coke operation $1,710 cheaper than when using electric energy.—Editor.]

What's New in Plant Equipment

HOW THE MANUFACTURER CONTRIBUTES TO THE JOB OF GENERATING TRANSMITTING AND APPLYING THE POWER SERVICES



Three types of valve-operating units

Electric-, Air-Motor and Cylinder-Operated Valves

THE ACCOMPANYING illustration shows the line of power-valve-operating equipment now being put out by Crane Company, 836 South Michigan Ave., Chicago. The line includes type C motor control, type C air-motor control, and a cylinder-operated unit.

An important feature of the type C motor control, shown in the left-hand view of the illustration, is flexibility. It can be placed in a number of positions in relation to the valve bonnet. The entire motor unit and control are mounted on a pad on the valve yoke. This pad can readily be swung around the yoke to a desired position without disturbing the rest of the valve.

A lost-motion feature is also incorporated in the drive, which furnishes a hammer blow to unseat the disk of the valve and permit the motor to attain full speed before it encounters the disk load. The hammer blow is struck directly on the stem nut and is produced by a lug on the main gear coming into contact with a lug on the stem nut. The motor is of the high-speed high-torque type and is connected to a single worm-gear reduction unit which is totally inclosed.

A combined mechanical limit switch and torque cut-out are employed in the control. The limit switch functions in the opening direction only, operating indicator lights to show the position of the gate and to stop the motor when the valve is fully open. The torque cut-out operates in the closing of the valve only. In addition to protecting against damage should the disk close against an obstruction, the torque cut-out compensates for any variation in the valve seating due to temperature changes.

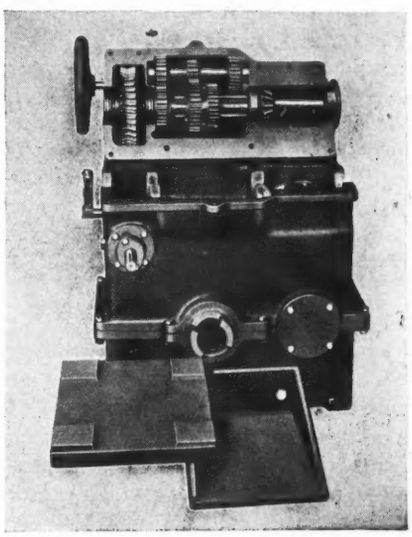
Speed and simplicity characterize the cylinder operation shown in the center view. The control consists of a cylinder mounted on the valve yoke and a four-way cock to control the operating fluid. The cock serves the double purpose of admitting the operating fluid to one end of the cylinder and at the same time exhausting the pressure on the other side of the piston. When used on low-pressure medium and standard valves the piston rod is usually extended through the top of the cylinder head to indicate the position of the gate. On high-pressure valves a hand releasing device is usually incorporated in the control.

The type C air-motor control, shown in the right hand view, embodies the principal mechanical features of the type C electric motor control previously described with an air motor connected to the driving worm in place of the electric motor. The motor is of balanced-type piston-valve construction, with four or more single-acting cylinders arranged in pairs. Rotation of the motor is controlled by a four-way cock. The unit may also be operated by remote control.

Speed Reducer for Stoker Drive

A THREE-SPEED REDUCER developed especially for application to automatic stoker drives is illustrated. Change of speeds is accomplished by a handwheel operating a threaded shaft, upon which the shifting fork is mounted.

The change gearbox has a splined shaft which is an extension of the worm gear shaft and is mounted on two sets of roller bearings, and also a jackshaft upon which two sets of change gears are mounted. The sliding gears on the splined shaft engage



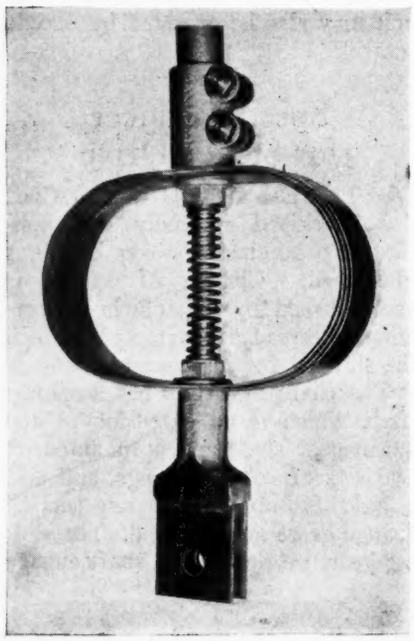
Reducer with top section opened to show transmission

either one of the change gears, or, by means of a clutch, engage the gear mounted on the worm-gear shaft. The unit is put out by Gears & Forgings, Inc., Cleveland, Ohio.

Combination Support and Expansion Joint

IN SUBSTATION construction it is often necessary to protect bushings of oil circuit breakers, transformers, etc., against thermal expansion of their conductors and misalignment due to unequal settling of structure footings. When leads are long or the arrangement requires a rigid conductor, it is usually necessary to carry at least part of the conductor weight on the bushing.

A type of joint designed especially to meet these conditions has been brought out by the Delta-Star Electric Company, Chicago, Ill. In this joint the weight is carried on a spring, the stiffness of which can be regulated to the amount of load carried.



Support and expansion joint

Improved Self-Contained Return-Tubular Boiler

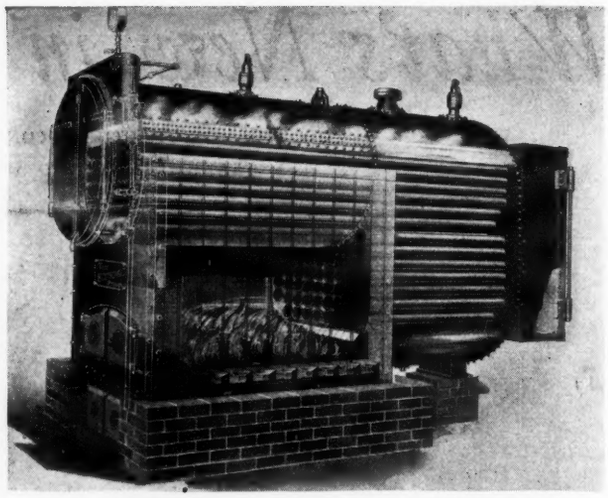
REPLACEMENT of the principal cast-iron parts with steel-plate construction wherever practical is one of the important improvements made recently to the "Economic" boiler put out by the Erie City Iron Works, Erie, Pa.

With the exception of the fire- and ash-pit doors, which are of cast iron, a complete steel front can now be furnished with a welded-steel stack saddle on the smoke box. The rear combustion chamber is also of steel and is refractory-lined. A complete steel ash pit eliminates the need of any outside brickwork below the furnace.

Another improvement that aids combustion in the furnace is a refractory bridge wall in front of the first pass section of the boiler. This is used in all sizes.

A firebrick arch of special design is used over the firing doors, and a dead air space is provided on the side walls of the furnace by means of special-shaped refractory. The dead air space reduces materially radiation through the furnace walls.

Units ranging from 100 to 2,000 sq.ft. of heating surface for pressures of 100, 125 and 150 lb. and adaptable to all methods of firing are available.



Phantom view of Economic boiler fitted with steel front and rear combustion chamber

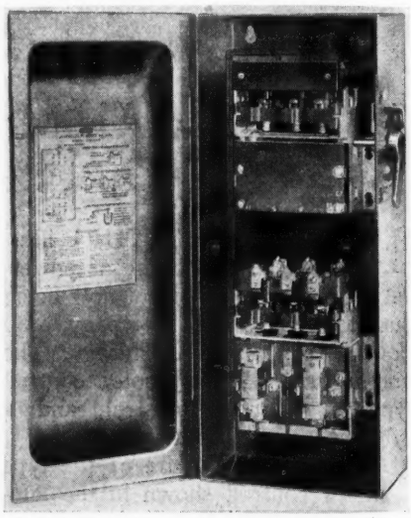
Detachable Watt-Hour Meter

DETACHABLE watt-hour meters that can be plugged into place or removed readily through the use of plug terminals have been introduced by the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa. The meter is housed in a weather-proof case, making it suitable for use either indoor or outdoor.

Meter with plug terminals

Across-the-Line Starter With Motor Circuit Switch

THE Condit Electrical Manufacturing Corporation, Boston, Mass., announces that its standard across-the-line alternating-current motor starters may now be furnished equipped with a hand-operated motor circuit switch, as required by the National Electrical Code. For further security, beyond the requirements of the code, both the starter and motor circuit switch will open the same overload. Both are housed together in a sturdy safety case, forming a compact piece of equipment. The starters are furnished with or without fuse clips and meter test jacks. With the latter incorporated in the starter the motor can be tested for load without interfering with machine operation. Starters are furnished up to 20 hp. 550 volts; 10 hp. 220 volts; and 5 hp. 110 volts.



Combination motor starter and motor circuit switch

Events and Men in Power's Field

THE EDITORS WILL WELCOME THE CO-OPERATION OF READERS IN REPORTING INTERESTING HAPPENINGS, PERSONAL OR OTHERWISE

Spot * News

EXCEPTIONS *to the findings and proposed decree submitted by the special master, Charles Evans Hughes, in the Chicago diversion case were filed in the United States Supreme Court, Feb. 3, by the Great Lakes States, Sanitary District of Chicago and the State of Illinois. The last two objected to the time required to place the sewage disposal plants in full operation and the amount of diversion recommended, while the Great Lakes States contended that there should be complete cessation of diversion after the plants are operating.*

* * *

SEPARATION *of ownership and control of the companies affiliated with the Aluminum Company of America whose business is directly connected with manufacturing from those engaged in the public utility power business has been approved by the Public Service Commission of New York.*

* * *

CONSTRUCTION WORK *on the second unit of Tacoma's (Wash.) Cushman power project may be stopped by an injunction suit filed by the local Labor Council. It is alleged that provisions in the contracts calling for the employment of Tacoma labor at certain wage scales have been violated, and the council is bringing suit to enforce these provisions.*

* * *

THE KENTUCKY SENATE *has opened the way for hearings on the question of whether Cumberland Falls shall become a power plant or a state park by adopting a resolution providing that anyone interested in the project shall be given a hearing.*

* * *

AS A RESULT *of differences with Governor Roosevelt over the function of the New York Public Service Commission, William A. Prendergast resigned as chairman on Feb. 4. The Governor believes the commission should be an aggressive representative of the consumer, while Mr. Prendergast considers it a purely judicial body.*

Plans for British Power Grid Completed With Southwest Scheme Ready

COMPLETING PLANS for an inclusive interconnected power system in Great Britain, a comprehensive electricity scheme for the whole of Southwest England and South Wales has just been prepared by the British Electricity Commissioners and put in the hands of the Central Electricity Board for carrying into effect. The scheme deals with an area of about 17,234 square miles which at the last census had a population of 6,085,500.

Under the plan six existing stations and two new stations (one in the neighborhood of Southampton and one in South Wales) will be operated for the Central Electricity Board. The six public generating stations now in operation which have been selected are: Cardiff, Hayle (Cornwall), Newport, Portishead (Bristol), Southampton, and Upper Boat (South Wales). The plan also provides for the working, if necessary, of eleven other generating stations under temporary arrangements between the central board and the owners.

Base Load Allocations

In providing for the future demands in the area it is contemplated that the base load output will be allocated as far as possible to the selected stations at Portishead and Upper Boat; and that the remaining requirements will be met by four other selected stations with the assistance of those worked under temporary arrangements. The generating stations not used for base-load purposes will be worked as required for meeting the peak-load demands in the area. While the plan provides only for the operation as required of seventeen stations for the purposes of the central board, it contemplates that certain of the remaining public generating stations in outlying portions of the area will continue to be operated independently for the time being until, by reason of further development, it becomes economically practicable for the operators concerned to obtain supplies in bulk either directly or indirectly from the system of the Central Board.

The power stations will be interconnected by a series of high-voltage main transmission lines, designed in a series of ring mains so that there will be alternative routes to points of supply and consequently greater security against breakdown. The main transmission system will comprise 622 route-miles of line and 25 transforming stations. The interconnection of these stations will, it is stated, result in the release for revenue-earning purposes of about 180,000 kw. of generating plant now kept as spare and representing about $15,300,000 of capital. The transmission system for the southwestern area will connect up through Reading, and possibly along the south coast also, with the system of the central board in southeast England; and through Worcester with the system of the board in Central England, thus becoming a contributory portion of the comprehensive system for Great Britain.

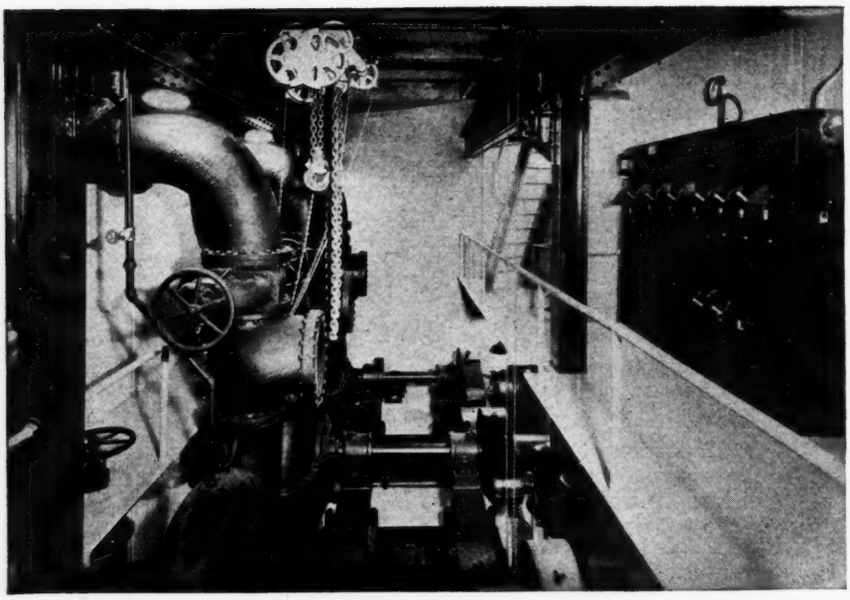
To Standardize 20 Systems

The plan involves standardization of twenty undertakings, including the South Wales Electrical Power Distribution Company and the Cornwall Electric Power Company, at an estimated cost of $3,822,250. The cost of the transmission system is estimated at $20,819,420. In addition, there will be an expenditure of about $9,671,800 on extensions of certain existing stations. It is estimated that the full advantages of the scheme can be secured with a saving of about $6,917,530 on capital expenditure (up to the year 1936-37), compared with the expenditure that would be necessary if the present system were continued. After this date, it is stated, the saving would be progressively greater compared with individual development.

Rates to Be Reduced

Sir Harry Haward, one of the electricity commissioners, states that charges in the area will be reduced. This is the seventh regional plan prepared by the commissioners. The first, in 1927, related to Central Scotland. The sixth, dealing with Northeast England, is still under consideration, but it is hoped that it will be adopted within a short time.

The seven plans account for 94 per cent of the area of England and Wales, and 98 per cent of the population. A plan for East England, comprising the county of Norfolk and practically the whole of Suffolk, is now in hand. North and South Scotland yet remain to be dealt with. In the past three years programs have been prepared by the commissioners covering practically the whole of England and Wales, and the most important part of Scotland.



PARTIAL VIEW of the new storm-drain-disposal plant recently placed in operation by the City of Los Angeles, Calif. Five 10,000-g.p.m. Fairbanks-Morse centrifugal pumps are individually motor-driven through American high-speed chain drives. The motors are automatically float-controlled, so that any one or number of pumps may work singly or in unison, as required

Potomac Park Bill Passed With Power Amendment

With only 24 votes cast against it, the Cramton bill providing for the $23,000,000 George Washington memorial parkway, was passed by Congress Jan. 30. The bill provides for the purchase of a narrow strip of land on each side of the Potomac from Chain Bridge, at the District of Columbia line, to a point just above Great Falls. Similar purchases are authorized on several creeks tributary to the Potomac.

The bill was amended on the floor so as to provide "that the acquisition of any land in the Potomac River Valley for park purposes shall not debar, or limit, or abridge its use for such works as Congress may in the future authorize for the improvement and the extension of navigation, including the connecting of the upper Potomac river with the Ohio river, or for flood control, or irrigation, or drainage, or for the development of hydroelectric power." Another amendment precludes the construction of a private toll bridge within the confines of the parkway, and another makes mandatory a free bridge at or near Great Falls.

Objection to the bill was based almost entirely on the proposition to set up a parkway without expressed recognition of the development of the resources of the Potomac for navigation and power, and for control of floods. While it is admitted that it will be very difficult to secure legislation in the future permitting of power or navigation developments within a park area, it was apparent that the amendment, which was offered by Representative Dempsey of New York, was the only compromise obtainable in the House. There was objection, also, on the ground that the bill should not be acted upon until a report can be made on the survey of the river now being made by the Army engineers. General Jadwin, formerly Chief of Engineers, had reported that combined park and power development is feasible. He also opposed the type of park that would be "prodigal of the latent resources of the Potomac" and the waste of great potential values "for debatable minor scenic considerations."

Sperry Is First Recipient of A.I.S.I. Medal

Elmer A. Sperry, past president of the American Society of Mechanical Engineers and president of the Sperry Gyroscope Company, has been awarded the American Iron and Steel Institute medal, one of two medals established by the institute as a memorial to Elbert H. Gary, its founder and first president. Charles M. Schwab, chairman of the board of the Bethlehem Steel Corporation and president of the institute, made the formal presentation of the medal to Dr. Sperry, who is the first recipient of the honor.

Awarded at the general meeting of the institute last October, when Dr. Sperry was in Tokio attending the World Engineering Congress, the medal was bestowed on him for his paper describing the method he developed for detecting flaws in steel rails, which he later applied to the testing of welds in bars, plates and rods.

Texas High-Pressure Plants to Burn Oil and Gas

Texas' first 1,400-lb. steam plants will be equipped to burn natural gas and oil, according to the latest information on these two stations.

The Houston Electric Lighting & Power Company is expanding its Deepwater steam-electric station at Houston by adding two boiler units, each having a maximum capacity of 350,000 lb. of steam per hour at a pressure of 1,450 lb. per square inch. They will each be fired by twenty Peabody combined gas and mechanical oil burners with the 4-in. insulated-panel type of air register front plates. One burner on each boiler will be fitted with a hinged insulated front air register, which can be swung out of the wind-box to provide easy access to the furnace.

The San Antonio Public Service Company is installing a boiler unit in Station B in San Antonio to have a capacity of 215,000 lb. of steam per hour at a pressure of 1,400 lb. per square inch. It will be fired by ten Peabody combined gas and mechanical-atomizing oil burners equipped with 4-in. insulated-panel air register front plates.

Stream Gaging Discussed at Geological Meeting

Meeting to discuss the recent progress of stream-gaging technique, the biennial conference of the water resources branch of the United States Geological Survey was held from Jan. 20 to 25 in Washington. Some 50 engineers were in attendance. All 30 of the districts covering the United States and Hawaii were represented by delegates from the field offices. Representatives from other government bureaus and from the Canadian service also took part in the sessions. It was brought out that the publication of stream-flow data, which has fallen behind due to insufficient funds and personnel, is now being pushed, so that the results of investigations will soon be made available.

Several new pieces of equipment were exhibited. Among these was the Au-Lee reel and boom for use in making stream-gaging measurements from bridges with cable suspension. The frame is collapsible, so that the whole device may be carried in a small trunk. Soundings are registered directly on a dial. Meter weights up to 50 lb. can be used. One of the advantages of the reel is that it permits suspension of the meter by a single fine wire, with the return circuit for the electrical contact passing through the water. This decreases greatly the resistance of the cable to high velocities, reducing errors from this cause.

The meter problem was extensively discussed, the general opinion being that the Price meter now in use satisfies present requirements of the service, which demands a meter applicable with

reasonable accuracy to all types of service ordinarily met in the field. Under working conditions it would be difficult to apply different types to different purposes. Evidence from several districts was brought to bear by comparison with salt velocity and volumetric measurements and with other tests to show that the Price meter checks discharges within 2 per cent, which is well within usual needs. Most criticisms of the Price type was aimed at design rather than principle. Concerning its use in streams laden with ice or pulp waste, the Canadian delegate pointed out that débris often collects in the meter cups. He stated that his government is attempting to devise a propellor-type meter that will stand up under field conditions.

Other subjects before the conference were: single-wire suspension, streamline meter weights, telephonic head sets, and new developments in recording gages. A new type of chain gage, using a wire of the airplane strand type, and an electric contact gage for stilling wells were described. Discussions as to hydraulic theory included the use of slope stations, corrections of records for rising or falling stage, critical velocity (the point on rising stages where turbulence begins), and other complex, specialized problems. The relations between the Water Resources Branch and the Federal Power Commission, work on streams crossing international boundaries, and state cooperation were other topics of discussion.

Sale of Boulder Dam Power Being Studied

Final contracts for the actual sale of power, embodying the full generating capacity of Boulder Dam, are being worked out and closed rapidly, it was stated orally Feb. 3, at the Department of the Interior, according to a report in the *United States Daily*. The question of power allocation, preference rights, and other related matters, such as rates and methods of power distribution, are still in tentative stages of disposal, the statement said.

The secretary of the department, Ray Lyman Wilbur, has just returned from an extensive two weeks' tour of the Boulder Dam territory and the Kettleman Hills oil field in California.

Secretary Wilbur had no comment to make on recent legislative references in regard to legal interpretations rendered by the solicitor of the department on certain phases of the Boulder Dam project and federal water-power acts, other than to say that the issues now pending before the department were under consideration and that his actions on them "would be guided to some extent on the basis of judicial and departmental interpretations; but the decisions as rendered by the solicitor are not, in any way, mandatory upon the department."

Business Forecast

MOST of the week's crop of business indicators are disappointing, and those that are not are a bit puzzling by contrast. Steel production, according to figures being given out, continues to gain so rapidly that the lost ground since the stock market crash has about been recovered and there is some curiosity as to whether there will be very much more left to recover this month unless general trade conditions improve faster than they do. The bridge of building activity between the fall and spring seasons is sagging. Freight movement and check money turnover are feeble. and commodity prices have been subject to fainting spells, in which Farm Board maneuvers in commodity markets have not helped. The slump in prices of the great staples is not in itself so unfavorable a factor—except for the foreign trade outlook—as is the prosect of prolonged uncertainty and unsettlement in commodity markets which government intrusion involves.

Columbia River Projects Held Up by Senate

Power permits or licenses on the Columbia River between the Grand Coulee Dam site and the Canadian border are held up by a resolution introduced by Senator Dill and adopted on Jan. 31 after having been held in committee only a week. The effect of this measure is to prevent construction either at Grand Coulee or at Kettle Falls above until the Engineer Corps has completed its investigation and has issued its report as to the uses of the stretch of river in question. A preliminary permit was issued to the Washington Water Power Company for the latter project in 1921 and an application for license has been pending since 1925. Advocates of the Grand Coulee development, which concerns power and, principally, irrigation, would build a dam to drown out part of the head at Kettle Falls.

Utility Hearing Postponed

The first hearing of the Federal Trade Commission's public utilities investigation on the financial phase has been postponed until Feb. 18, when the financial structure of the American Gas & Electric Company will be investigated. Additional time was found necessary to enable company officials and the commission staff to prepare their data. Both government examiners and company officers will testify. The principal subjects of inquiry will be capital structure and service contracts.

News of Canada

Latest Figures Place Canada Among Largest Users of Water Power—East Kootenay to Develop Elk River—Beauharnois Asks for More Land

FIGURES compiled by the water-power branch of the Government show that total installation for the Dominion now averages 584 hp. per 1,000 of population, a figure which places Canada among the leading countries of the world in per capita utilization of water power. The present turbine installation of 5,727,162 hp. represents only slightly more than 13 per cent of recorded water-power resources.

The report points out that known available water power in the Dominion, from all sources, is 20,347,000 hp. for conditions of ordinary minimum flow and 33,617,200 hp. ordinarily available for six months of the year. Further, an analysis of water-power plants scattered from coast to coast, concerning which complete data are available as to turbine installation and information as to stream flow, shows the average machine installation to be 30 per cent greater than the ordinary six-month flow power. Applying this, the figures quoted above indicate that the present recorded water-power resources of the Dominion will permit of a turbine installation of about 43,700,000 horsepower.

Elk River Project

The East Kootenay Power Company has prepared plans for the development of the Elk River, at Phillip's Canyon, in the southeastern interior of British Columbia. The company has applied to the provincial water board for the right to dam the Elk at a point about ten miles below the town of Elko to create between 15,000 and 20,000 hp. A high dam, impounding the waters of the Elk in its famous canyon, will be constructed.

Beauharnois Progress

Although only a small percentage of the work has been undertaken on the big Beauharnois power development scheme on the St. Lawrence, the company has already applied to the Quebec Legislature for an enlargement of its powers in the matter of expropriation of lands necessary for building its canal between Lake St. Francis and Lake St. Louis. Under a statute passed in 1923 the company was empowered to expropriate such lands as might be necessary, not exceeding in all six arpents in width. This is changed in a bill now before the Legislature to 21 arpents in width. The plans of the company call for a present development of 500,000 hp., half of which, under contract with the Quebec government may be sold to the Province of Ontario. Arrangements for the sale of this have already been announced. The ultimate purpose of the company is to develop 2,000,000 hp. and, in view of recent events, it is not expected that serious objections will be made to such increased development.

OBITUARY

EVERETT S. THURSTON, manager of the building division of the Westinghouse Electric & Manufacturing Company, Seattle, Wash., died of heart failure Jan. 25. Mr. Thurston had long been identified with the electrical industry, both on the Pacific Coast and in Montana, and had spent many years in the electrical jobbing business before joining the Westinghouse company in July, 1925. For three years Mr. Thurston was Westinghouse merchandising representative for Montana, with headquarters in Butte. In August, 1928, he was transferred to the Seattle office, where he was made manager of the building division.

HENRY HOLGATE, prominent in Canadian engineering circles, died Jan. 21 at his home in Montreal in his 68th year from an attack of angina pectoris. He was born at Milton, Ontario, and educated in Toronto, and was for some years engaged in railway and bridge construction. He established himself in Montreal in 1894, where his activities were largely devoted to hydro-electric development. He spent some years in Jamaica, where he constructed and managed the hydro-electric tramway system at Kingston. On his return to Montreal in 1901 Mr. Holgate entered into partnership with Robert E. Ross, and during the ten years of partnership they constructed many hydro-electric plants, including those of the West Kootenay Power Company and the Canadian Copper Company. In 1911 he became president of the Cedar Rapids Power Company, and when he retired from that position he was retained by the company as consulting engineer.

PERSONALS

A. C. MECKLENBURG has severed his connection as chief engineer with the Murdock Pump Company and is establishing a consulting engineering office in Indianapolis, Ind.

A. E. ZIMMERMAN, of the Pelton Water Wheel Company, was recently elected president for 1930-31 of the Society of Engineers, San Francisco, Calif. H. T. SUTCLIFFE, of the operating department of the Pacific Gas & Electric Company, was elected vice-president, and W. G. RAWLES, of the East Bay Municipal Utility District, was made treasurer of the society.

GUY L. BAYLEY and HARRISON SMITH, engineers, have been admitted as partners to the firm of Sanderson & Porter, consulting engineers of New York City. Mr. Bayley is in charge of the Chicago office of the firm.

W. D. BURGESS has been transferred from his former position in the engineering department of the El Paso Electric Company, El Paso, Texas, to become power engineer in the industrial service department of that company In his new position Mr. Burgess will assist E. R. WOOLLEY, head of the industrial service department.

W. H. TALBOTT, of the San Diego Consolidated Gas & Electric Company, was elected president of the Engineers' Club of San Diego, Calif., at the recent annual meeting of the club. Other officers for the coming year are: vice-president, R. D. WATTS, assistant engineer of the Bureau of Water Development, City of San Diego; treasurer, E. H. SMITH, manager of the American Concrete Pipe Company; secretary, R. E. JENSON, consulting engineer.

DURBIN VAN LAW, mechanical engineer, of Denver, Colo., has become associated with the Fuel Efficiency Engineering Corporation, Birmingham, Ala., as general manager.

C. P. SPELLMAN has been placed in charge of the newly organized statistical department of the El Paso Electric Company, El Paso, Texas. J. P. SHUMATE has been transferred from the engineering department to act as Mr. Spellman's assistant.

RALPH R. WOOLLEY, hydraulic engineer for the United States Geological Survey, with headquarters at Salt Lake City, has been named a member of a board appointed by the Federal Power Commission to examine the properties of the Idaho Power Company. Mr. Woolley expects to begin the examination the early part of February.

Coming Conventions

American Society of Mechanical Engineers. Fiftieth Anniversary Celebration at New York City, Hoboken, N. J., and Washington, D. C., April 5-9, 1930. Semi-Annual meeting at the Hotel Book-Cadillac, Detroit, Mich., June 9-12, 1930. Secretary, Calvin Rice, 33 West 39th St., New York City.

American Institute of Electrical Engineers. District meeting at Springfield, Mass., May 7-10. Annual summer convention at Toronto, Canada, June 23-27. Secretary, F. L. Hutchinson, 33 West 39th St., New York City.

American Society for Testing Materials. Annual meeting at Haddon Hall, Atlantic City, N. J., June 23-27. Secretary, C. L. Warwick, 1315 Spruce St., Philadelphia, Pa.

American Welding Society. Annual meeting at society headquarters in New York City, April 22-25. Secretary, M. M. Kelly, 33 West 39th St., New York City.

Association of Iron and Steel Electrical Engineers. Annual convention and iron and steel exposition at Broadway Auditorium, Buffalo, N. Y., June 16-20. Managing director, John F. Kelly, Empire Building, Pittsburgh, Pa.

Canadian Electrical Association. Annual Convention at the Manoir Richelieu via the S.S. "St. Lawrence," June 11-13, 1930. Secretary, H. M. Lyster, 405 Power Building, Montreal, Quebec.

Engineering Institute of Canada. Annual meeting at the Chateau Laurier, Ottawa, Ont., Feb. 12-14, 1930. Secretary, R. J. Durley, 2050 Mansfield St., Montreal, Que.

International Congress for General Mechanics at Liege, Belgium, Aug. 31 to Sept. 7, 1930. For information address Alb. Schlag, 4 Place Saint-Lambert, Liege, Belgium.

International Railway Fuel Association. Annual meeting at the Hotel Sherman, Chicago, Ill., May 6-9. Secretary, C. T. Winkless, Room 700, LaSalle St., Station, Chicago, Ill:

National Electric Light Association. Annual convention at Municipal Auditorium, San Francisco, Calif., June 16-20, 1930. Secretary, A. J. Marshall, 420 Lexington Ave., New York City.

National Marine Engineers' Beneficial Association. Annual convention at Hotel Barlum, Detroit, Mich., the week of Feb. 10, 1930. Secretary, A. L. Jones, 9th St. and Mount Vernon Place, N. W., Washington, D. C.

National Oil and Gas Power Meeting, under auspices of A.S.M.E. Oil and Gas Power Division and Pennsylvania State College, will be held at State College, Pa., June 12-14. Chairman, L. H. Morrison, c/o *Power*, 10th Ave. and 36th St., New York City.

New England States Association of the National Association of Power Engineers. Annual convention and exhibition of power machinery at the State Armory, Salem, Mass., June 19-20, 1930. Secretary, E. S. Daniels, 113½ Bridge St., Salem, Mass.

Second Plenary World Power Conference. Convenes at Berlin, German, June 16-25. Chairman of the American Committee, O. C. Merrill, Edmunds Building, Washington, D. C.

BUSINESS NOTES

W. H. BIXBY, INC., sales representative for the AMERICAN ENGINEERING CORPORATION, has moved its main office from Omaha, Neb., to 1004 Hubbell Bldg., Des Moines, Iowa.

COMBUSTION ENGINEERING CORPORATION, New York City, announces the appointment of James Cleary as general sales manager. Mr. Cleary joined the organization in 1921 and has served successively as district manager at Philadelphia and Detroit.

MORTON VACUUM BREAKER COMPANY and CLOUGH ENGINEERING COMPANY, both of Canton, Mass., have incorporated for the sum of $100,000,000 under the name of the MORTON-CLOUGH ENGINEERING COMPANY, to manufacture vacuum breakers and do general engineering work, consulting and erecting. Officers of the new firm are: Perley Clough, president; S. N. Morton, treasurer; D. S. Morton, clerk.

EDWARD VALVE & MANUFACTURING COMPANY, East Chicago, Ind., are now represented in the Easton-Allentown-

Reading district of Pennsylvania by W. E. Groff, 1121 Maple St., Bethlehem, Pa., who succeeds the W. E. Groff Company of Easton. The company has also appointed the Maintenance Engineering Corporation, 1400 Conti St., Houston, Texas, to represent it in the El Paso territory, which includes southern New Mexico and western Texas.

FREEMAN MANUFACTURING COMPANY, Racine, Wis., announces a reorganization with L. A. McDowell, president; Arthur Janes, vice-president; Victor D. Werner, secretary. Mr. McDowell was formerly general manager of the H. & M. Body Corporation, of Racine, and previous to that he was in charge of manufacturing and engineering for the Murray Corporation of America.

IRONTON FIRE BRICK COMPANY, Ironton, Ohio, announces the appointment of Stegall & Company as its representative in Chattanooga, Tenn. The Ironton company has also appointed the Knoxville Sand & Lime Company to represent it in Knoxville, Tenn.

RELIANCE ELECTRIC & ENGINEERING COMPANY, Cleveland, Ohio, has established an office at 207 Richardson Bldg., Toledo, Ohio, to serve northwestern Ohio, northern Indiana and southern Michigan. C. E. Stine, formerly of the Detroit office, will be in charge of the new office.

UNION CARBIDE COMPANY and ELECTRO METALLURGICAL COMPANY, both units of the Union Carbide & Carbon Corporation of New York City, announce the election of Benjamin O'Shea, formerly president, as chairman of the board of each company. Fred H. Haggerson, formerly vice-president of the two companies, succeeds Mr. O'Shea as president, and F. P. Gormely was made vice-president and general manager of both companies.

With the Society Sections

A.S.M.E., Anthracite-Lehigh Valley Section. Meeting at the Necho-Allen Hotel, Pottsville, Pa., at 6 p.m., Feb. 28. Subjects: "The New Hellgate Plant at New York City," by J. B. Gaffney, Allentown, Pa., and "Electric Hoists for the Mining Industry," by A. J. Nicht, Milwaukee, Wis.

A.S.M.E., Detroit Section. Meeting on Feb. 12 at the Detroit Engineering Society rooms. Subject: "Lubrication," by Mayo D. Hersey, chief of lubrication, Bureau of Standards.

A.S.M.E., Louisville Section. Joint meeting with A.I.E.E. and Engineers & Architects Club at 403 Norton Bldg., on Feb. 18 at 8 p.m. Subject: "The Quest of the Unknown," by Prof. Harold B. Smith, president of the A.I.E.E.

A.S.M.E., Philadelphia Section. Meeting in the auditorium of the Engineers Club on Feb. 25 at 8 p.m. Subject: "The Relation of River and Harbor Problems to the Hydraulic Laboratory," by H. M. Eaton, Bureau of Standards.

A.S.H. & V.E., Philadelphia Chapter. Regular meeting at the Engineers Club on Feb. 13. Subject: "Heating and Ventilating of School Buildings," by John D. Cassell, superintendent of buildings, Board of Education.

A.I. & S.E.E., Philadelphia Section. Meeting at the Engineers Club on March 1. Subject: "Magnetic Clutches in Industry," by H. E. Hodgson, Cutler-Hammer Corporation.

A.S.S.T., Philadelphia Chapter. Meeting at the Engineers Club on Feb. 28. Subject: "Corrosion-Resistant Steels," by Henry A. De Fries, Ludlum Steel Company.

Midwest Bituminous Coal Conference. Held under the direction of the Engineering Schools of Purdue University, Coal Trade Association of Indiana and Illinois Coal Bureau, at Lafayette, Ind., April 9-11. Chairman, W. A. Knapp, Purdue University, Lafayette, Ind.

Providence Engineering Society. Power section meeting in the society rooms on Feb. 11 at 8 p.m. Subject: "Automatic Combustion and Boiler Feed Water Control," by H. M. Hammond, Bailey Meter Company.

Engineering Societies of Boston. Annual dinner and gala entertainment will be given at the Copley Plaza Hotel on Feb. 12.

TRADE CATALOGS

CONDENSERS—Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., has just issued a new 4-page leaflet, No. 20435, illustrating and describing the construction and application of jet condensers. Another leaflet, No. 20424, contains data on the construction of surface condensers, and a third leaflet, No. 20442, describes in detail the combination Sharples centrifuge and filter-press oil purifier.

WELDING — Bulletins GEA-874E. -875E and -876D describe and illustrate 200-, 300- and 400-amp. arc-welder sets of the General Electric Company, Schenectady, N. Y. Full details on the new Types FK-330 and FHK-330 station oil circuit breakers, rated at 15,000-25,000 volts and 600-4,000 amp., are given in another bulletin of the company, No. GEA-987A.

ROPE DRIVES — The latest booklet (No. 1228-K) on Texrope Drives issued by the Allis-Chalmers Manufacturing Company, Milwaukee, Wis., contains 25 pages of illustrations and descriptions of the application of these drives to sixteen industries.

CHARTS—A complete description of graphic chart sheets, data sheets and loose-leaf books manufactured by the Codex Book Company, 461 Eighth Ave., New York City, is contained in a 104-page illustrated booklet recently issued by the company. Many helpful hints on keeping records and data will be found in this publication.

COUPLINGS—The subject of flexible couplings is thoroughly covered in a new 24-page illustrated bulletin (No. 37) of the Morse Chain Company, Ithaca, N. Y. Data are given on the proper way to select couplings, their ratings, dimensions and prices. Speed reducers are also explained, as is the Morse power-transmission service.

FUEL PRICES

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run, except Pittsburgh gas slack:

Bituminous (Net Tons)	Market Quoting	Price per Ton
Navy Standard	New York	$2.20 @$2.30
Kanawha	Columbus	1.30 @ 1.60
Smokeless	Cincinnati	2.00 @ 2.25
Smokeless	Chicago	2.25
S. E. Kentucky	Chicago	1.35 @ 1.60
Steam	Pittsburgh	1.25 @ 1.60
Gas Slack	Pittsburgh	1.00 @ 1.15
Big Seam	Birmingham	1.25 @ 1.50
Anthracite (Gross Tons)		
Buckwheat	New York	$2.50
Barley	New York	1.40@ 1.50

FUEL OIL

New York—Feb. 6, f.o.b. Bayonne, N. J., 28@34 deg., Baumé, industrial use, tank-car lots, 4.75@5.5c. per gal.; f.o.b. Bayway, 36@40 deg., furnace, tank-car lots, 6c. per gal.

St. Louis—Jan. 23, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1.695 per bbl., or 42 gal.; 26@28 deg., $1.745 per bbl.; 28@30 deg., $1.795 per bbl.; 30@32 deg., $1.845 per bbl.; 32@36 deg., gas oil, 4.401c. per gal.; 37@40 deg., distillate, 5.23c. per gal.

Pittsburgh—Feb. 3, f.o.b. local refinery, 30@34 deg., fuel oil, 4.5@4.75c. per gal.; 36@40 deg., 4.62½@4.75c.

Philadelphia—Feb. 1, 13@19 deg., $1.05@$1.10 per bbl. or 42 gal.; 22 deg. plus, $1.575@$1.625 per bbl.; 23@27 deg., $2.10@$2.15 per bbl.

Cincinnati — Jan. 28, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 5.25c. per gal.; 26@30 deg., 5.5c. per gal.; 30@32 deg., 5.75c. per gal.

Chicago—Feb. 1, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 90c. per bbl. or 42 gal.; 22@26 deg., 85@90c. per bbl.; 26@30 deg., $1.02½@$1.07½ per bbl.; 30@32 deg., $1.30@$1.35 per bbl.

Boston—Feb. 2, tank-car lots, f.o.b., 12@14 deg., Baumé, $1.05 per bbl.; 30@32 deg., 5c. per gal.

Dallas—Feb. 1, f.o.b. local refinery 26@30 deg., $1.35 per bbl. or 42 gallons.

New Plant Construction

COMPILED BY THE MCGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

Calif., Glendale — City awarded contract for the construction of a sub-station to H. M. Baruch Corp., 1015 Lincoln Bldg., Los Angeles. Estimated cost $37,436.

Calif., Los Angeles — Hollywood Business Properties Inc., 633 Hollywood Blvd., is having preliminary plans prepared for the construction of a 12 story office and stores, including steam heating system, etc, at 1728 North Hudson Ave. Estimated cost $1,000,000. B. M. Priteca, Pantages Bldg., is architect.

Conn., Hartford—Hartford Electric Light Co., 266 Pearl St., awarded contract for the construction of a 1 story, 60 x 60 ft. boiler house on South Meadows to Stone & Webster, Inc., 24 Federal St., Boston, Mass. Estimated cost to exceed $40,000.

Conn., Watertown—Taft School, H. D. Taft, Pres., Bd. of Trustees, will receive bids until Feb. 12 for the construction of a 1 story, 62 x 66 ft. boiler plant. Estimated cost $40,000 including equipment. J. G. Rogers, 154 East 46th St., New York, N. Y., is engineer.

Ill., Chicago—A. C. Weisberg & Associates, 33 North La Salle St., are having plans prepared for the construction of a 12 story hotel, etc., at Wabash Ave. and Harrison St. Estimated cost $3,467,755. A. S. Alschuler, Inc., 28 East Jackson Blvd., is architect.

Kan., Wichita—Allis Hotel Building Co., A. R. Brasted, Secy., will soon award contract for the construction of an 18 story hotel at William and Lawrence Sts. Estimated cost $1,500,000. Schmidt, Boucher & Overend, Brown Bldg., are architects. A. H. Gentry, March Bldg., Kansas City, is associate architect.

Ky., Paducah—City is having plans prepared for the construction of a power plant. Burns & McDonnell Engineering Co., 400 Interstate Bldg., Kansas Bldg., Mo., is engineer.

Md., Baltimore — Baltimore Life Insurance Co., 17 West Saratoga St., awarded contract for the construction of an 8 story office and stores building at Saratoga and Charles Sts. to J. H. Miller, Inc., Eutaw and Franklin Sts. Estimated cost $750,000. Steam heating system, etc. will be installed.

Massachusetts—Worcester Suburban Electric Co, R. H. Alton, Uxbridge, will build three substations in Douglas, also transmission line from Douglas to Uxbridge. Estimated cost $125,000. Private plans. Work will be done by day labor.

Mass., Mattapan (Boston P. O.)—Hospital Dept., J. J. Dowling, 819 Harrison Ave., Boston, will soon award contract for additions and alterations to power plant and laundry at Tuberculosis Hospital, River St., here. Estimated cost $190,000. James H. Ritchie & Associates, 100 Arlington St., Boston, are engineers.

Mass., Pittsfield—Pittsfield Electric Co., W. A. Whittlesey, Pres., is having preliminary plans prepared for addition to power plant including equipment, also extension to lines at Silver Lake. Estimated cost $250,000. Private plans.

Mass., Plymouth — Cape Refrigerating Co., awarded contract for the construction of an ice plant to J. Lalagucci, Plymouth. Estimated cost $42,500. Equipment contract let.

Mass., Roxbury (Boston P. O.)—Edison Electric Illuminating Co., C. L. Edgar, Pres., 39 Boylston St., Boston, awarded contract for the construction of a 48 x 51 ft. electric substation on Hampshire St. here, to J. M. Tobin, Inc., 40 Central St., Boston. Estimated cost $40,000.

Mich., Howell — Detroit Edison Co., 2000 Second Blvd., Detroit, is having plans prepared for the construction of an outdoor sub-station including new synchronous condenser unit, etc. Estimated cost $135,000.

Mo., Campbell—City plans an election Feb. 11, to vote $20,000 bonds to defray part of construction cost, etc. for municipal power plant and distribution system. Total estimated cost $60,000. Russell & Axon, 6200 Easton St., St. Louis, are engineers.

N. J., Asbury Park — E. H. Schneider, 3rd Ave., Spring Lake, Archt., will receive bids about Feb. 15, for the construction of an 11 story apartment building including steam heating, ventilation and refrigeration systems, boilers, elevators, etc. at Grand and 5th Aves. here, for Peoples Building & Construction Co., 218 Sanford St., New Brunswick. Estimated cost $500,000.

N. J., Jersey City — Harris & Sohn, 58 Park Pl., Newark, Archts., will receive bids about Mar. 1, for the construction of a 10 story medical office building including steam heating, and ventilation systems, boilers, elevators, etc. at Tonnelle and Sip Aves. for Journal Sq. Medical Bldg., Inc., W. J. Quinn, Pres., c/o Dept. of Revenue & Finance, City Hall. Estimated cost $1,000,000.

N. Y., New York — New York Hospital, Cornell Medical College, awarded contract for second unit of new medical center, including nurses home, swimming pool, power plant, laundry, etc., at East 70th and 71st Sts., York Ave. and Exterior St., to Marc Eidlitz, 41 East 42nd St.

N. Y., Tonawanda—Buffalo General Electric Co., subsidiary of Buffalo, Niagara & Eastern Power Co., Electric Bldg., Buffalo, has work under way on the construction of a section at south end of River Rd. power station, consisting of 100,000 hp., 3 ph., 25 cycle generator; new section at north end consisting of two 107,000 hp., 3 ph., 60 cycle generators. Cost of work under construction will exceed $500,000. Derdenger Construction Co., Electric Bldg., Buffalo, is contractor. Another section is contemplated for the near future.

Ore., Grants Pass — City is having surveys made for the construction of a waterworks system, pumping and filtration from Rogue River or gravity system with dams and reservoirs from creeks about 15 mi. from here. Estimated cost $350,000 to $600,000. Barr & Cunningham, Spalding Bldg., Portland, are engineers.

Tex., Refugio—City plans an election in February to vote $125,000 bonds for waterworks and sewage system including pumping unit, etc.

Texas—Emery, Peck & Rockwood Development Co., 208 South La Salle St., Chicago, Ill., taking bids sub-contracts and materials, etc., for power dam on the Colorado River near Kingsland. Estimated cost $8,000,000. Work will be done under the supervision of owners. Six dams to be built on the Colorado River. Total estimated cost $17,000,000.

Tex., Trinidad — Texas Power & Light Co., Interurban Bldg., Dallas, plans extensions and improvements to power plant including a 40,000 kw. turbine and generator unit and two 32,000 sq.ft. pressure boilers. Estimated cost $75,000. Private plans. Work will be done by owners forces.

British Columbia — East Kootenay Power Co., Fernie, has made application to provincial water board for permit to construct a new hydro-electric power plant and dam on Elk River at Phillip's Canyon in Crow's Nest Pass of region to develop 15,000 to 20,000 hp.

Ont., Toronto—Yolles & Rotenburg, 372 Bay St., plans the construction of a 20 story office building, including steam heating system, electric elevators, etc. Estimated cost $1,500,000. Chapman & Oxley, Sterling Tower Bldg., are architects.

Russia — Union Soviet Socialist Republica, plan an industrial program involving expenditures of more than $10,000,000,000 during next five years as follows: 4 large plants for manufacture of automobiles, trucks and motorcycles; 8 factories for farm implements and tractors; 6 asbestos, and graphite factories; 15 factories for manufacture of machine tools, equipment, typewriters and cash registers; 2 locomotive works; 24 cement plants, 126 saw mills; 106 woodworking plants; 27 glass factories; 15 woolen mills; 13 clothing factories; 15 paper mills and 56 plants for manufacture of food products; 224,500 kw. power plants, etc. 1930 budget for new construction and improvements to existing plants $1,900,000. Albert Kahn, Inc., 1004 Marquette Bldg., Detroit, Mich., are consulting architects. Address Amtorg Trading Corp., 261 5th Ave., New York, N. Y.

Equipment Wanted

Engines—St. Louis, Mo.—U. S. Engineer's Office, War Dept., Washington, D. C., is receiving bids for two 70 hp. 6 cylinder, vertical 2 cycle Marine Diesel engines, here.

Pump—Essex, Ont.—City Council, is receiving bids for the installation of a 250 g.p.m. waterworks pump, etc.

Pump—Kitchener, Ont.—City plans the installation of a new 1 m.g.p.d. electric centrifugal pump in pumping station. Estimated cost $15,000.

Pump, etc.—Hastings, Mich.—City plans to purchase a motor driven centrifugal pump and auxiliary equipment for proposed pump house and sewage disposal plant. Estimated cost $25,000.

Pumps, etc.—Erie, Pa.—City, J. S. Dunwoody, Supt. of Waterworks, motor driven high and low service pumps, etc., for proposed waterworks system. Estimated cost $700,000.

Transformers—London, Ont.—Public Utilities Commission, prices on three 1,500 kw., 13,000 v. to 2,300 transformers.

Industrial Projects

Calif., Los Angeles—A. Monaco, Pershing Sq. Bldg., Archt., is receiving bids for the construction of a 5 story factory on 37th Pl. for Mission Hosiery Co., 3746 Moneta.

Ind., Fort Wayne—City Carriage Co., 629-31 South Barr St., awarded contract for the construction of a factory at 514 East Wayne St., to W. S. Sams, 2239 New Haven St. Estimated cost $47,000.

Mich., Jackson—Artic Dairy Products Co., N. Durand and Daniel Rd., is having plans prepared for the construction of a 1 and 2 story, 200 x 240 ft. creamery, including bottling plant, power house, etc. Estimated cost $150,000. Private plans. New bottling equipment will be installed.

Mo., St. Louis—Sieloff Packing Co., Newstead and Natural Bridge Ave., awarded contract for the construction of a 1 story 30 x 120 ft. boiler room addition to packing plant at 3616-20 North Newstead Ave., to A. H. Haeseler Bldg. & Contg. Co., 621 Wainwright Bldg.

N. J., Belleville—F. G. Nobbe, 1630 Springfield Ave., Maplewood, Archt., is receiving bids for a 1 and 2 story factory on Main St. for Napier Hat Mfg. Co., 104 Main St., Belleville. Estimated cost $50,000.

N. J., North Bergen—Theurer Wagon Works, Inc., 601 West 56th St, New York, N. Y., will build a 3 story addition to factory at 3923-47 Hudson Blvd., here. Estimated cost $40,000. G. Urllaredt, 411 23rd St., West New York, is architect. Work will be done by separate contracts.

N. Y., Olean—Olean Metal Cabinet Works, is having plans prepared for the construction of a factory. Estimated cost $350,000. A. W. E. Schoenbery, Olean, and O. Johnson, Jamestown, are architects.

O., Cleveland — Chain Products Co., F. G. Hodell, Pres., 3924 Cooper Ave., is having plans prepared for a 1 and 2 story, 28 x 96 ft. addition to factory. Estimated cost $40,000. Carter-Richards Co., Engineers Bldg., Archt.

O., Cleveland—The Kroehler Mfg. Co., Fisher Bldg., Chicago, Ill., manufacturers of furniture, is having plans prepared for a 3 story, 80 x 200 ft. addition to factory at East 116th St. and Harvard Ave., here. Estimated cost $200,000. J. O. Taylor, c/o owner, is architect.

O., Philo—Ohio Ferro-Alloy Corp., Witters Bldg., Canton, plans the construction of a 1 story, 80 x 250 ft. factory here. Estimated cost $50,000 to $75,000. Private plans.

Ore., Eugene — Pacific Paper Products Co., A. A. Rogers, Pres., plans the construction of a 1 story paper mill. Estimated cost $500,000. P. J. Lamoureux, is architect and engineer. Work will be done by day labor. Pulp and paper machinery, engines, dynamos, etc. will be required.

Pa., Oil City—Oil City Glass Bottle Co., subsidiary of Knox Glass Bottle Co., R. R. Underwood, Pres., Marienville, awarded contract for the construction of a 1 story, 50 x 200 ft. glass factory here to Clairon Blox Co., Clarion.

Pa., Tarentum—Tarentum Steel Co., W. Coke, V. Pres., 1716 First National Bank Bldg., Pittsburgh, will receive bids about Mar. 1, for the construction of a steel plant including mills, cranes, docks, railroad sidings, office and equipment, here. Estimated cost $3,000,000. L. F. Galbraith, Tarentum, is engineer.

Tex., Newgulf—Texas Gulf Sulphur Co., 41 East 42nd St., New York, N. Y., awarded contract for additions to sulphur mining plant here to J. G. White Engineering Co., 43 Exchange Pl., New York.

Tex., San Antonio—Gunter Hotel Co., T. B. Baker, Gunter Hotel, plans to enlarge laundry plant and remodel boiler room. Private plans. Machinery and equipment including five boilers will be purchased and installed.

Ont., Fergus—Beatty Bros., is having plans prepared for a 1 story, 60 x 180 ft. addition to factory for the manufacture of electric washing machines. Work will be done by owners forces.

Ont., Hamilton—Eaton Knitting Co., W. F. Eaton, Pres., John St., will soon award contract for the construction of a 2 story, 100 x 250 ft. addition to factory on John St. Estimated cost $200,000. Private plans. Equipment for the manufacture of various lines of knitted goods will be installed.

Ont., Toronto—Yardleys Ltd., 358 Adelaide St. W., awarded contract for the construction of an 8 story, 71 x 101 ft. factory to Jonckheere Construction Co., 1207 Bay St. Estimated cost $250,000.

PRICES - MATERIALS - SUPPLIES

Electrical prices on following page are to the power plant by jobbers in the larger buying centers east of the Mississippi. Elsewhere the prices will be modified by increased freight charges and by local conditions.

SINCE LAST MONTH

PIPE and boiler covering carry lower discounts this month with firmer tendencies also noted in boiler tubes. The babbitt metal advance of 1c. per lb. last month is followed by a similar increase in February, to 58c. per lb., New York warehouse delivery. Linseed oil is off 1.1c. per lb., to 14.8c., at New York, indicating the present downward trend in paint materials.

POWER-PLANT SUPPLIES

HOSE—Quotations at New York warehouses:

	Fire Protection	50-Ft. Lengths
Underwriters' 2½-in., coupled, single jacket		(net)*60c. per ft.
Common, 2½-in., cotton, rubber-lined, 80c. per ft., list, less		50%

Air—Best grade		
¾-in., per ft.	3-ply....$0.30	4 ply....$0.36

Steam—Discounts from List		
First grade....40%	Second grade.....45%	Third grade....50-10%

RUBBER BELTING—List price 6-in., 6 ply, $1.83 per lin.ft. The following discounts from list apply to rubber transmission belting:

Best grade.....50% Second grade.....60%

LEATHER BELTING—List price, 24c. per lin.ft., per inch of width, for single ply, at New York warehouses:

Grade	Discount from list
Medium	30-10%
Heavy	30%

RAWHIDE LACING—For cut, best grade, 30-5%; 2nd grade, 45-5%. For laces in sides, best, 57c. per sq.ft.; 2nd, 52c., net. Semi-tanned, cut, 30-5%.

PACKING—Prices per pound at New York warehouses:

Rubber and duck for low-pressure steam, ¾ in.	$0.90
Asbestos for high-pressure steam, ¾ in.	1.75
Duck and rubber for piston packing	.90
Flax, regular	1.15
Flax, waterproofed	1.70
Compressed asbestos sheet	.85
Wire insertion asbestos sheet	1.20
Rubber sheet	.45
Rubber sheet, w. e insertion	.75
Rubber sheet, duck insertion	.55
Asbestos packing, twisted or braided and graphited, for valve stems and stuffing boxes	1.40
Asbestos wick, ¾- and 1-lb. balls	.50

PIPE AND BOILER COVERING—Discounts from list at New York warehouses are as follows:

85% magnesia, high pressure		40 %
Asbestos, air cell, for low-pressure heating and return lines	4-ply	65 %
	3-ply	67½%
	2-ply	70 %

PORTLAND CEMENT—New York, $2.30 per bbl., without bags, delivered by truck to site of job. Bag charge, 40c. per bbl.

STRUCTURAL STEEL—New York delivered price, beams and channels, 3 to 15-in.; angles, 3 to 6-in., ¼-in. thick; tees, 3-in. and larger; and plates, ¼-in. thick and heavier; all $3.30 per 100 lb. in lots up to 3,999 lb.

COTTON WASTE—The following prices are in cents per lb., at warehouse:

	New York	Cleveland	Chicago
White	13.00	16.00	15.00
Colored	9.50	12.00	12.00

WIPING CLOTHS—Prices per pound in lots of about 600 lb., for washed white wipers, as follows:

Chicago (100 lb. bales)	$0.16
New York (100 lb. bales)	.12½
Cleveland (per thousand)	38.00

LINSEED OIL—These prices are for raw oil in barrels, f.o.b., in 1 to 4 bbl. lots:

	New York	Cleveland	Chicago
Per pound	$0.148	$0.164	$0.159

WHITE AND RED LEAD—Per 100-lb. keg, base price, f.o.b., New York:

	Dry	In Oil
Red	$13.75	$15.25
White	13.75	14.25

RIVETS—The following quotations apply on fair-sized orders from warehouse:

Tank rivets, $\frac{7}{16}$-in. diameter and smaller, list (Apr. 1, 1927) less 60% in full packages, for immediate delivery from warehouse stocks in New York and vicinity.

Structural rivets, ½-in., round head, per 100 lb.:

New York	$4.50*
Chicago	4.00
Pittsburgh mill	3.10

*This price is for full kegs; broken kegs are $6.00 per 100 lb.

REFRACTORIES—Prices in car-loads, f.o.b. plant:

Chrome brick, eastern shipping points	per net ton	$45.00
Chrome ore, ground, 40@50%, Cr_2O_3, in bulk	per net ton	22@25
Chrome ore, ground, 40@50%, Cr_2O_3, in sacks	per net ton	26@29
Chrome ore, crude, 40@50%, Cr_2O_3	per net ton	18.00@22.50
Magnesite brick, 9-in. straights	per net ton	65.00
Magnesite brick, 9-in. arches, wedges and keys	per net ton	71.50
Magnesite brick, soaps and splits	per net ton	91.00
Silica brick, Mt. Union, Pa	per M	43.00
Clay brick, 1st quality, 9-in. shapes, Pennsylvania	per M	43@46
Clay brick, 1st quality, 9 in. shapes, Ohio	per M	43@46
Clay brick, 1st quality, 9 in. shapes, Kentucky	per M	43@46
Clay brick, 1st quality, 9 in. shapes, Maryland	per M	43@46
Clay brick, 2nd quality, 9 in. shapes, Pennsylvania	per M	35@38
Clay brick, 2nd quality, 9 in. shapes, Ohio	per M	35@38
Clay brick, 2nd quality, 9 in. shapes, Kentucky	per M	35@38
Clay brick, 2nd quality, 9 in. shapes, Maryland	per M	35@38

BABBITT METAL—Delivered in case lots from New York warehouse, on orders of 100 lb. or over, cents per pound:

Genuine, highest grade	58.00
Commercial genuine, intermediate grade	42.00
Anti-friction metal, general service	31.00
No. 4 babbitt, f. o. b.	11.50

COLD DRAWN STEEL—Shafting and screw stock, warehouse prices per 100 lb., base, are as follows:

	New York	Cleveland	Chicago
Round or hexagon	$3.50	$3.65	$3.60
Flat or square	4.00	4.15	4.10

BOILER FITTINGS—F.o.b. warehouse, Jersey City, N. J., discounts from list:

Copper ferrules	70%
Boiler flanges	65–5%
Boiler stay bolts	60%
Boiler patch bolts	20%
Boiler fitting-up bolts	45%
Pressed steel boiler lugs	10%

WROUGHT PIPE—The following basing discounts from list are for large mill lots at Pittsburgh mill:

BUTT WELD

	Steel			Iron	
Inches	Black	Galv.	Inches	Black	Galv.
1 to 3	62%	50½%	1 and 1¼	31%	15%

LAP WELD

2	55%	43½%	2	23%	9%
2½ to 6	59%	47½%	2½ to 3½	28%	13%
7 and 8	56%	43½%	4 to 6	30%	17%
9 and 10	54%	41½%	7 and 8	29%	16%
11 and 12	53%	40½%	9 to 12	26%	11%

BUTT WELD, EXTRA STRONG, PLAIN ENDS

1 to 1¼	60%	49½%	1 to 2	34%	18%
2 to 3	61%	50½%			

LAP WELD, EXTRA STRONG, PLAIN ENDS

2	53%	42½%	2	29%	13%
2½ to 4	57%	46½%	2½ to 4	34%	20%
4½ to 6	56%	45½%	4½ to 6	33%	19%
7 and 8	52%	39½%	7 and 8	31%	17%
9 and 10	45%	32½%	9 to 12	21%	8%
11 and 12	44%	31½%			

BOILER TUBES—Standard gage, manufactured in accordance with the specifications and requirements of the American Society of Mechanical Engineers and in compliance with the rules and regulations of the U. S. Steamboat Inspection Service, from New York warehouse stock, per 100 ft.:

Size, Inches*	B.W.G.	Toncan Seamless Iron	Knobbled Charcoal Iron	Seamless Steel	Lapwelded Steel
1	13	$34.00	.....	$18.00	.....
1¼	13	37.75	.....	20.25	.....
1½	13	38.00	$38.00	19.25	.....
1¾	13	30.00	30.00	22.00	.....
2	13	26.25	26.25	20.25	$19.00
2¼	13	34.50	34.50	23.00	25.00
2½	12	34.00	34.00	26.00	24.25
2¾	12	40.50	40.50	28.50	27.50
3	12	42.50	42.50	27.00	25.50
3½	11	50.25	50.25	30.75	28.75
3½	11	54.50	54.50	33.25	31.50
4	10	67.00	67.00	40.00	38.00

These prices are based on stock lengths. If cut to special lengths billing will be based on the entire stock lengths. In addition to the foregoing, standard cutting charges are as follows:

2-in. and smaller.. $0.05 per cut
2¼ and 2½ in..... .06 per cut
3-in..... $0.09 per cut
3½ to 4 in.. .10 per cut

*External diameter.

ELECTRICAL SUPPLIES

ARMORED CABLE—Price per 1,000 ft., New-Style, A.B.C., with fibre bushing:

B. & S. Size	BX Two Cond. M. Ft.	BX Three Cond. M. Ft.	Lead Two Cond. M. Ft.	Lead Three Cond. M. Ft.
No. 14 solid....	$33.85 (net)	$48.00 (net)	$180.00	$220.00
No. 12 solid....	136.00	180.00	225.00	275.00
No. 10 solid....	185.00	235.00	275.00	325.00
No. 8 stranded..	305.00	375.00	420.00	500.00
No. 6 stranded..	440.00	530.00	615.00	.....

From the above lists discounts are:	BX	Lead Covered
Less than coil lots	50%	30%
Coils to 1,000 ft.	60%	34%
1,000 to 5,000 ft.	63%	36%
5,000 ft. and over	65%	48%

CONDUIT—Price per 1,000 ft.; **ELBOWS AND COUPLINGS,** per 100 pieces, extra, f.o.b. New York warehouse. Discount of 5 per cent. for payment in 10 days. No delivery charges, regardless of quantity.

Size Inches	Conduit Black Per M Ft.	Conduit White Per M Ft.	Elbows Black Per 100	Elbows Galvanized Per 100	Couplings Black Per 100	Couplings Galvanized Per 100
⅛–¼	$52.96	$57.80	$6.96	$8.05	$4.23	$4.63
½	67.28	73.83	9.16	10.59	6.04	6.61
1	96.22	105.91	13.56	15.67	7.84	8.59
1¼	130.18	143.29	18.63	21.20	11.08	12.04
1½	155.65	171.33	24.84	28.26	13.68	14.88
2	209.42	230.51	45.54	51.81	18.24	19.84
2½	331.11	364.46	74.52	84.78	26.06	28.34
3	432.99	476.60	198.72	226.08	39.09	42.51
3½	546.94	599.38	438.84	499.26	52.12	56.68
4	668.72	730.85	507.15	576.98	65.15	70.85

CONDUIT BODIES AND FITTINGS—Black or galvanized.

	Less Than $10 List	$10 List to $100	$100 List and Over
Standard package	10%	20%	28%
Less than standard package	5%	10%	20%

CUT-OUTS—Following are net prices, each, in standard-package quantities:

CUT-OUTS, PLUG, SOLID, NEUTRAL OR 2-FUSE

S. P. M. L.	$0.12	D. P. D. B.	$0.31
D. P. M. L.	.16	T. P. S. B.	.35
T. P. M. L.	.27	T. P. D. B.	.47
D. P. S. B.	.16		

CUT-OUTS, N. E. C. FUSE, SOLID, NEUTRAL OR 2-FUSE

	0-30 Amp.	31-60 Amp.	60-100 Amp.
D. P. M. L.	$0.27	$0.70	$1.75
T. P. M. L.	.40	1.00	2.30
D. P. S. B.	.35	.87	.....
T. P. S. B.	.67	1.50	.....
D. P. D. B.	.65	1.75	.....
T. P. D. B.	1.12	3.00	.....
T. P. to D. P. D. B.	.75	2.10	.....

FLEXIBLE CORD—Price per 1,000 ft. in coils of 250 ft.:

No. 18 cotton reinforced heavy		$21.50
No. 16 cotton reinforced heavy		25.00
No. 18 cotton reinforced light		15.50
No. 16 cotton reinforced light		22.00
No. 18 cotton Canvasite cord		17.00
No. 16 cotton Canvasite cord		27.00
No. 16 super service cord or similar (2 wire) in 1,000 ft.	$70.80	*76.70
No. 14 super service cord or similar (2 wire) in 1,000 ft.	106.20	*115.05

*Less than 1,000 ft.

NATIONAL ELECTRIC CODE FUSES, NON-REFILLABLE—

250-Volt	Std. Pkg.	List	600-Volt	Std. Pkg.	List Each
3-amp. to 30-amp.,	100	$0.15	3-amp. to 30-amp.,	100	$0.30
35-amp. to 60-amp.,	100	.30	35-amp. to 60-amp.,	100	.60
61-amp. to 100-amp.,	50	.90	65-amp. to 100-amp.,	50	1.50
101-amp. to 200-amp.,	25	2.00	110-amp. to 200-amp.,	25	2.50
201-amp. to 400-amp.,	25	3.60	225-amp. to 400-amp.,	25	5.50
401-amp. to 600-amp.,	10	5.50	450-amp. to 600-amp.,	10	8.00

Discount: Less than one-fifth standard package, 60%; one-fifth to standard package, 65%; standard package, 68%.

RENEWABLE FUSES—List price each:

Sizes	250-Volt List-Price	600-Volt List-Price	Std. Pkg. Quantity	Carton Quantity
1 to 30-amp.	$0.50	$1.10	100	10
35 to 60-amp.	1.00	1.25	100	10
65 to 100-amp.	2.00	3.00	50	5
110 to 200-amp.	4.00	5.00	25	5
225 to 400-amp.	7.50	11.00	25	1
450 to 600-amp.	11.00	16.00	10	1

REFILLS—

1 to 30-amp.	$0.03 ea.	$0.05	100	100
35 to 60-amp.	.05 ea.	.06	100	100
65 to 100-amp.	.10 ea.	.10	50	50
110 to 200-amp.	.15 ea.	.15	25	50
225 to 400-amp.	.30 ea.	.30	25	25
450 to 600-amp.	.60 ea.	.60	10	10

Discount Without Contract—Fuses:	
Broken cartons	Net list
Unbroken cartons	17%
Ten unbroken cartons	34%
Discount Without Contract—Renewals:	
Broken cartons	Net list
Unbroken cartons	17%
Ten unbroken cartons	34%
Discount With Contract—Fuses:	
Broken cartons	5%
Unbroken cartons	20%
Ten unbroken cartons	36%
Discount With Contract—Renewals:	
Broken cartons	Net list
Ten unbroken cartons	36%

Carton quantities may be combined to obtain maximum discounts.

FUSE PLUGS, MICA CAP—

0–30 ampere, standard package (500), per 100	$2.80
0–30 ampere, less than standard package, per 100	3.10

LAMPS—Below are present quotations in less than standard package quantities on Mazda standard, A type bulbs:

100—130 Volt Watts	General Type	Price Each	200—260 Volt Watts	Special Type	Price Each
15	A 17	$0.20	25	A 19	$0.25
25	A 19	.20	50	A 21	.25
40	A 21	.20	100	A 23	.45
50	A 21	.20	...	....	.....
60	A 21	.20	...	....	.....
100	A 23	.35	...	....	.....

Standard pkg. quantities are subject to discount of 10% from list. Annual contracts ranging from $75 to $300,000 net, allow a discount of 15 to 40% from list.

PLUGS, ATTACHMENT—

	Each
Porcelain, separable, attachment plug	$0.18
Composition, 2-piece, attachment plug	.27
Swivel attachment plug	.12
Small size, 2-piece plug, composition	.07

RUBBER-COVERED COPPER WIRE—Per 1000 ft. f.o.b. New York:

No.	Solid Single Braid	Solid Double Braid	Stranded, Double Braid	Solid Duplex
14	$6.50	$8.90	$11.20	$19.00
12	9.90	11.40	14.00	25.00
10	13.50	15.40	18.50	33.50
8	19.90	22.50	25.00	47.50
6	.....	.....	36.00	.....
4	.....	.....	52.00	.....
2	.....	.....	72.00	.....
1	.....	.....	97.00	.....
0	.....	.....	119.00	.....
00	.....	.....	143.00	.....
000	.....	.....	176.00	.....
0000	.....	.....	215.00	.....

SOCKETS, BRASS SHELL—Price each, net:

	⅛ In. or Pendant Cap Key	Keyless	Pull	¼ In. Cap Key	Keyless	Pull
Standard package	$0.12	$0.10	$0.16	$0.16½	$0.14	$0.20
Unbroken carton	.14	.12	.18	.18	.16	.21
Broken carton	.16	.14	.20	.20	.18	.24

WIRING SUPPLIES—

Friction tape, ¾ in., in less than 100 lb., 31c. per lb.; in 100 lb. lots, 29c. per lb
Rubber tape, ¾ in., in less than 100 lb., 33c. per lb.; in 100 lb. lots, 31c. per lb
Wire solder, in less than 100 lb., 33c. per lb.; in 100 lb. lots, 31c. per lb.
Soldering paste, 2 oz. cans..... $1.10 doz.

ENCLOSED SWITCHES, KNIFE—Safety type, externally operated, 250 d.c or a.c., N.E.C.

TYPE "C" FUSED BOTTOM

Size, Amp.	Double Pole, Each	Three Pole, Each	Four Pole Each
30	$3.50	$5.70	$9.00
60	9.00	11.00	14.00
100	14.00	17.00	29.00
200	22.00	29.00	48.00

Discounts:	
Standard package	40%
Less than standard package	35%